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CIVIL ENGINEERING.

Screw Pile Pier, proposed by Lieut. EMORY, Top. Eng., *for an Ice Fender at Newcastle, Delaware. Communicated, with the Drawings, for the Journal of the Franklin Institute.*

Col. J. J. ABERT, Chief of the Corps of Top. Engs.

Sir,—In the fall of 1840, I submitted, through Major Hartman Bache, to the Bureau, a plan for the improvement of the harbor of Newcastle, in which it was proposed to use iron piles, secured by "Mitchell's Patent Mooring Screw," to form obstructions to the running ice.

This plan, it was believed, would effectually accomplish the desirable object of securing the harbor from the effects of ice without producing the evil heretofore encountered of retarding the passage of the water so much as to cause deposits of mud. The details of the plan, were, of course, imperfect. By the experience of Capt. Swift, and my own reflections, these have been much improved, and I herewith submit a sheet containing drawings of them, see Plate I.

The manner of attaching the collars and braces, is the same as that used by Capt. Swift, in the construction of the Black Rock Beacon. No change is proposed in the general plan, except to substitute a pier consisting of five iron piles, instead of nine, in one particular locality; that is, between the long wharf, and the southern unfinished pier.

This modification is made because this position is less exposed than

the others, and it is believed five piles are amply sufficient to resist any mass of ice that can come between the wharf and the pier.

It is not considered necessary to revise the estimates heretofore made, as the modifications proposed extend only to details involving no additional expense. I have the honor to be

Your most obt. servt.,

(Signed) W. H. EMORY,
1st Lieut. Top. Eng.

Topographical Bureau, May 20, 1844.

Explanations of Plate I.—Fig. 1, elevation of the pier; fig. 2, plan of braces and collars; fig. 3, top view of centre collars for braces; fig. 4, side view of centre collars for braces; fig. 5, top view of outside collars for braces; fig. 6, side view of outside collars for braces; fig. 7, mooring shackle *enlarged;* fig. 8, collar for mooring shackle; fig. 9, pile head; fig. 10, nut for pile head.

a, mooring shackle; *b*, collar for mooring shackle; *c*, covering plate; *d*, braces; *e*, outside view; *f*, inside view; *g*, Mitchell's screw.

The following detailed description of Mitchell's mooring screw, and its application to the construction of the Wyre light-house, was prepared for publication before our receipt of the foregoing article, and may be considered as an appropriate appendix to it: COM. PUB.

Description of Mr. Mitchell's Patent Screw Mooring, as being now laid down in the Port of London. By J. ELMES, Esq., Surveyor.

This sort of mooring is constructed, as its name implies, on the principle of the screw, but differing essentially in form from that well known instrument; for while the spiral thread makes little more than one turn round its shaft, it is, at the same time, extended to a very broad flanch, the hold which it takes of the ground being proportional with its breadth of disk.

Where it is necessary to provide against a very heavy strain, Mr. Mitchell has moorings of 3 feet 6 inches diameter, and the principle is capable of still further extension.

A mooring of the above diameter presents a resisting surface equal to about ten square feet; whereas the palm of the largest anchor in the British navy does not exceed half that size; and some estimate of its holding powers may be formed, when it is shown that this broad surface can be screwed to a depth many times greater than that to which the palm of an anchor can ever descend.

The method of laying down the mooring is briefly thus:—A strong mooring chain being so attached to it as to allow the screw to turn freely, without carrying the chain round with it, a powerful iron shaft is then fixed firmly in the upper part of the mooring, which is formed square for that purpose, setting in the same manner as a key to a harp, or piano forte, in winding up; it is then lowered by the mooring chain, joint after joint being added to the shaft till the mooring has reached the ground; light levers of 12 feet in length are then applied to the shaft in the manner of a capstan, when the operation of screwing the mooring into the ground commences.

Two boats, or barges, having been moored firmly, head and stern, close alongside each other, and the upright shaft rising between them about midships, the men place themselves at the bars, and move round from one boat to the other, the two giving them a safe and convenient platform; by a simple contrivance the levers are occasionally shipped upwards, as the screw and shaft sink into the ground.

When the number of men employed can no longer force the screw round, the levers are removed, and the shaft drawn out of the ground, leaving the mooring firmly imbedded with the chain attached to it; a buoy being shackled to the other end of the chain the work is completed, the time required for the whole operation seldom exceeding a few hours.

Fig. 11, Plate I, shows the screw mooring, as prepared for use. *a*, is a spiral, or screw, flanch of about one turn and a half, having a hollow cylindrical centre, as shown in fig. 12, and of cast-iron in one piece; *b*, is a wrought-iron spindle, which passes through the cylindrical socket of the screw flanch, somewhat tapering in form, as shown in fig. 13, and when driven up tight, is fixed thereto by a forelock, which passes through both; it is formed with a square head, *c*, to receive the key for screwing it into the ground; *d*, is a collar of wrought-iron, the front of which is shown in fig. 14, fitted so as to turn freely on the upper part of the shaft of the spindle below the collar. Fig. 12, shows the upper surface of the spiral flanch; fig. 13, the spindle; and fig. 14, the collar and shackle. The shackle is fixed to the spindle by means of the loose collar, in order to prevent the dragging round, and the consequent fouling of the chain, whilst the spindle is being turned in, or out, of the ground.

Civ. Eng. & Arch. Journ.

Description and Structure of the Wyre (Seaward) Lighthouse, leading to Port Fleetwood. *By* Com. H. M. DENHAM, R.N., F.R.S.

It was my study, when planning this navigation, to identify the remotest spit of bank turning into it, without subjecting the mariner to the treacherous, and, at best, but partially lighting agent, a *Light Vessel;* Messrs. Alexander Mitchell & Son, of Belfast, readily took up the proposition, and the Board of Directors of the railway and harbor project, as readily adopted the application of Mitchell's ingenious mooring screw to the insertion and basing of piles, or pillars, in sub-marine foundation. I had given much trouble to Messrs. Mitchell, when unavailingly submitting their plans and specifications to the Liverpool Dock Company, (Oct. 4, 1838,) of so perfect a mode of establishing lights *out upon the very* banks of a navigation, whereby the power and object of a light-house is enhanced by proximity with the anxious observer from sea. In fact, a light-house can be thus erected upon any *under-water* spit, as indifferent to a 30 feet rise of tide and channel surge, whilst sending forth its light of the same character and stability, as if on the main land; thereby throwing it more intensely and effectively *on the region required,* especially where

shoals out-lie the main to any extent. Its time in erection is the shortest possible,* and it is of so portable a structure, that it may be removed, if local changes require, to another site in a month. Wherefore, then, should not every spit, now guarded by a light vessel, with her unavoidably inferior order of lights, rendered more so in a gale of wind by pitching, floundering about, and ever and anon submerged in the trough of sea, spray, and spoon-drift, and that too when most wanted, and often at the very crisis of exigency to all around, *breaking adrift!* Wherefore not supersede them by so purpose-like a fabric? Let those who take interest, but who doubt, or cannot conceive, the matter, go to Fleetwoot Mount Observatory, commanding the mouth of the Wyre, and watch the effects of a westerly gale upon the first of its kind, (not associating the effects of a sea-way upon the Eddystone, or Bell Rock, for the screw-piled pillars *do not oppose* the sea.) A structure destined to save many a gallant bark, that would otherwise drive, unbeaconed and unwarned, upon the sands of Morecambe Bay, and I doubt not will give rise to a general adoption; whilst rendering it imperative on local guardians of a navigation, to establish *refuges* for the cast-away mariner, on the isolated banks; since, by this method, the practicability is manifested. Indeed, this sub-marine method of commanding foundation and *hold-fast*, so ingeniously contrived by Messrs. Mitchell, combines the vital essentials to the seaman's hope, of *warning*, *guiding*, *succoring*, and, when in port, *securing!* The figure of this first "screw-pile" light-house in the United Kingdom—in the world, I may say,—is shown in Plate II, and presents to the eye a well proportioned group of columns rising out of the sea, in the intervening and over lapping order that hexagonal, or six angled, figures produce, according to the separate angles you may be opposite to; a systematic interlacing of tension rods renders the fabric sufficiently opaque, even below the platform; but above the platform, of 27 feet diameter, you have a six angled dwelling house of 20 feet diameter, by 9 feet high; on the centre of which rises the 12 sided lantern, with Chinese roof, of 10 feet diameter. Thus, you have a figure of 46 feet spread at the base, contracting at the platform balcony to 27 feet, and elevated 45 above low water level; surmounted, as stated, by a bulky, yet pleasing and effective, superstructure, comprising a comfortable residence for the light keepers, whilst affording you a steady, bright, *uniform* light, 45 feet above the mean sea level, ranging over an eight mile horizon, visible 10 miles from a coaster's deck, and freed from those *breaks* of brilliancy attending the offing passage from reflector to reflector, by being fitted with a light of "*Dioptric*" order. Foggy periods are provided for by a self-acting deep sounding bell, tolling three strokes of five second intervals, at one minute pauses; and tide time for vessels of 12 feet draft, is denoted by two black balls being kept upon its flag-staff, until 12 feet ceases upon the *straight course, right up;* at the same time, however, denoting 17 feet up through the *buoyed* channel.

* The Wyre Light-house was reared in two of the shortest day months in the year, not affording *daylight* during a low water period, spring tides, but depending on flambeaus, or moonlight.

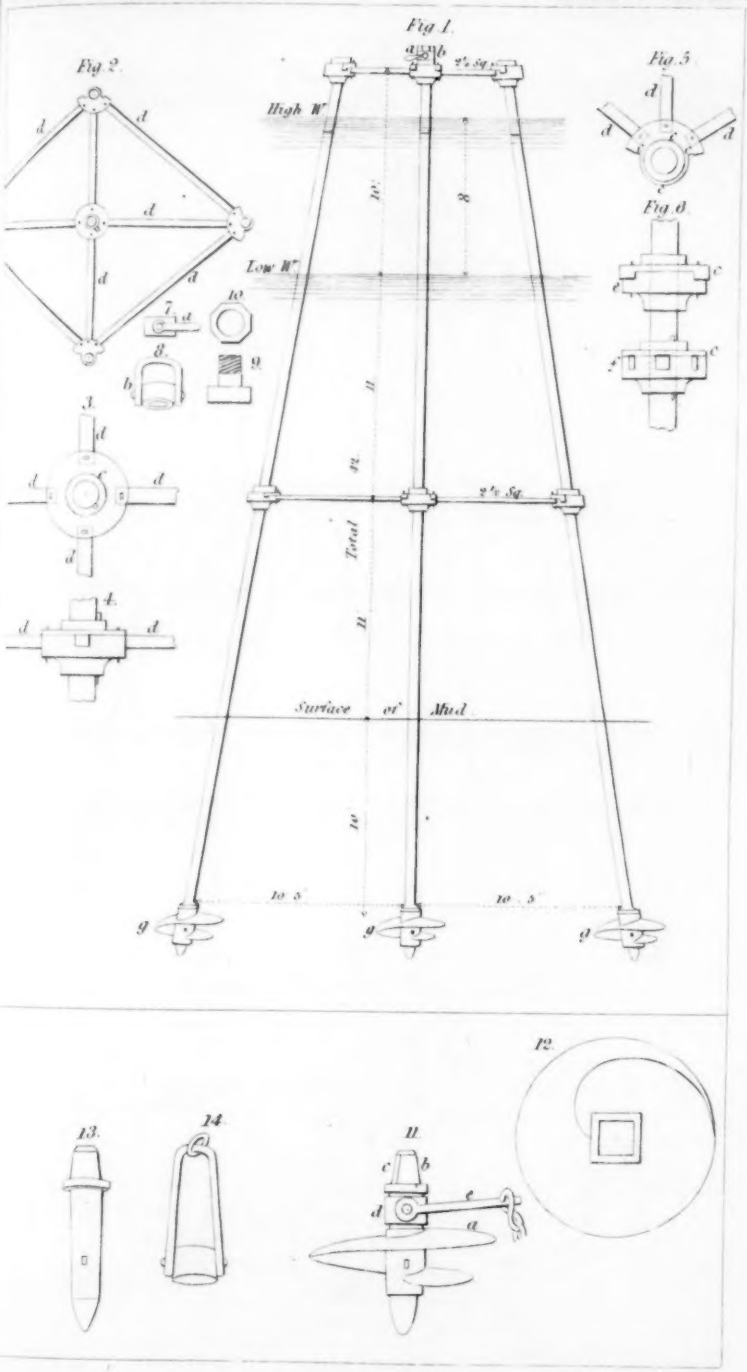


Fig 1.
Fig 2.
Fig 3.
Fig 4.
Fig 5.
Fig 6.
High W.
Low W.
2'x Sq.
Total
Surface of Mud
10 s
Fig 7.
Fig 8.
Fig 9.
Fig 10.
Fig 11.
Fig 12.
Fig 13.
Fig 14.

Fig 1.

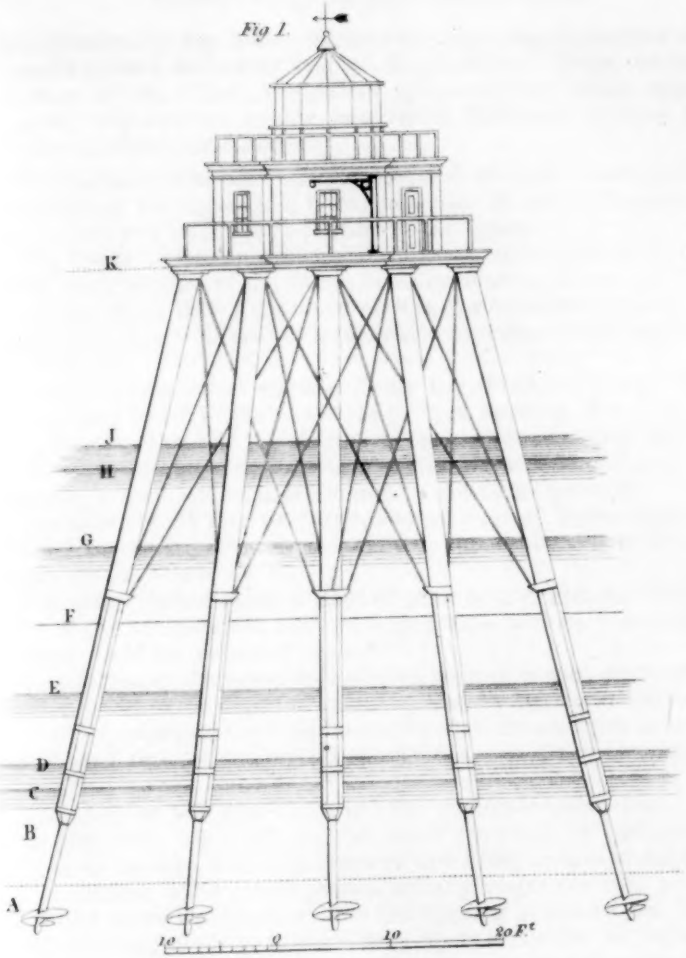


Fig. 4.

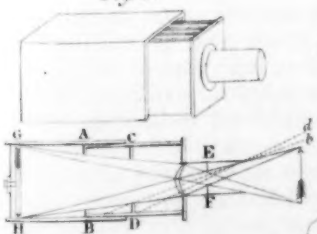


Fig. 3.

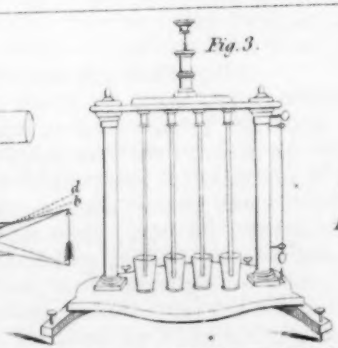
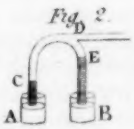


Fig. 2.



Specification of the above Screw Pile Light-house, erected on the north-eastern low water spit of North Wharf Bank, at the entrance of the Wyre Navigation, the structure being supported upon, and secured to, the bank with Mitchell's Patent Screw Piles of three feet diameter.

The foundation of the building is formed of seven screw piles, six of which are the angles of a hexagon, about 46 feet in diameter, and the seventh pile stands in the centre of the figure.

The heads of all the outer piles have an inclination inwards, by which the diameter of the frame work connecting the top of the columns, and upon which the house stands, is contracted to about 27 ft. Each screw pile is formed of a malleable iron shaft 15 ft. long, and 5 ins. diameter.

On each pile a 3 foot screw is firmly keyed near its lower extremity, beneath which is placed a large drill, or opening, bit.

At the upper end of the shaft is a screw of 18 ins. long, and 2 ins. diameter, for drawing down and screwing the wooden column to the iron pile, which latter stands about 5 ft. out of the ground.

The columns are thus prepared,—seven logs of Baltic timber are selected, of the largest and best quality; the centre one is 56 feet in length, all the others are 46.

The pedestals rise about a third of their height, and the remainder of the shafts are rounded, both for appearance and as lessening any vibration from the action of the sea.

An opening in the lower end of each column is then made of 5 ins. diameter, and to the depth of about 8 feet, by boring in the manner of a water pipe; strong iron hoops are then driven upon it, hot, the first about 8 feet up, the second about 4 feet, and the third at its lower extremity.

This hooping will give to the column greater strength than it originally possessed, especially as the wood removed by boring is the weakest in the tree, and adds scarcely any thing to its actual strength.

The column being raised perpendicularly above the iron pile, the end of the latter is introduced into the opening prepared for it, and which has been made to fit accurately upon it; when the top of the pile has reached the end of the cavity, screwing on (by capstan,) the foot of the column will be inserted in the bank about 3 feet; the wood, when wet, will clasp firmly on the iron, but, as an additional security, the internal screw attaches the two together.

The framing upon which the house stands is firmly secured round the centre column, and to the heads of the outer ones, by means of cast-iron capitals let down over the heads of the columns, the capitals being cast hollow for the purpose; to the abacus of these the top framing is secured with screw bolts passing down through the wood and iron, having nuts on the under side, all boring, or cutting, into the main support of the building being thus avoided, and the adjacent parts of the framing are bound together by wrought-iron straps and knees; the beams which radiate from the centre to the heads of the outer columns are 12 ins. deep by 7 ins. wide, and those which connect the head of the outer columns 12 ins. by 4.

To give lateral strength to the building to resist the effect of heavy bodies drifting against it, twenty-four angle braces from round iron of 1¼ inch diameter are applied, as shown in the plan, by which a resisting power equal, at least, to 350 tons, is presented in every direction; these braces are secured at the top to trusses cast with the capitals, and beneath to strong wrought-iron bands with projecting bolt holes; by these means boring into the columns is again avoided; the braces are keyed up at their crossing, as shown in the plan.

The light-keepers' house, which is hexagonal, is in diameter from angle to angle 22 feet, and 9 feet in height.

The centre column rises to the base of the lantern, which, with the roof, it assists to support, giving great additional stability to the whole structure.

The corner posts of the house are 7 ins. by 6, all remaining studs 6 ins. by 4, beams of roof 9 ins. by 5, and all outside planking, together with floor and roof of house, is 2 ins. thick.

The house has an outside door and three windows, and is divided into two apartments, one having a fire place and the floor tiled; the walls and ceiling of both apartments are lathed and stuccoed.

The lantern, which is 12 sided, is 10 feet in diameter, and in height to the top of the windows 8 feet, by which the lights are raised above the highest spring tide level about 31 feet, or 44½ above half tide level.

The lights (in this case of dioptric order) show throughout the periphery, and the roof is covered with strong sheet iron, (a lightning repeller and conductor, of course.)

The light-keepers' house is covered with sheet-lead, and a light iron railing is carried round the top of the building and the platform.

London, Jan. 31, 1840. HENRY MANGLES DENHAM.

Explanation of Plate II.—A, marl formation; the screws are 10 feet below low water mark; B, sub-stratum of sand; C, low water equinoctial springs; D, low water ordinary tides, 2 feet above ditto; E, low water neap tides, 9 feet above ditto; F, half tide level, 15 feet above ditto; G, high water neaps, 21 feet above ditto; H, high water ordinary tides, 28 feet above ditto; J, high water equinoctial springs, 30 feet above ditto; K, underside of platform, 45 feet above ditto; centre of the dioptric light in lantern, 60 feet above ditto. Ibid.

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*On the Pyramids of Egypt.** *By* J. J. SCOLES, Esq., F.R.I.B.A.

About three years since the two first parts of the magnificent work of Colonel Vyse, on the Pyramids of Egypt, were presented to the Institute, and Mr. Scoles then read a paper on the subject of the discoveries made by Colonel Vyse, and described the pyramids at Ghizeh. On the presentation of the concluding number of the work, he took the opportunity, on the last meeting of the Institute, to resume the subject, and to describe the further discoveries which have been made

* Read at the Royal Institute of British Architects.

in the pyramids situated at Sakkarah, Dashhour, and other places in the "Faioum;" and which are delineated in the third number from drawings by Mr. Perring, the civil engineer, under whose direction the various excavations were made at the expense of the gallant Colonel.

There appear to be thirty-nine pyramids in Middle and Lower Egypt, all of which have been explored by Mr. Perring. They are situate on the western side of the Nile, chiefly on the desert hills, occupying a space, measuring from north to south, of fifty-three English miles.

The first pyramid described by Col. Vyse, is known by the name of *Abou Roash;* the base is 320 ft. square. The bulk of it is built of the mountain rock, (a sort of hard chalk) which has been reduced to a level around it, and the defective places have been made good with masonry. No part of the external casing is to be found; indeed, the edifice was not probably ever completed, or raised to a considerable height. A passage about 160 ft. long, commencing on the north, and descending at an angle of 22° 35′, leads to an apartment about 40 ft. by 15 ft.; above it smaller chambers appear to have been constructed similar to those in the king's chamber in the great pyramid of Ghizeh, called "Chambers of Construction," because they relieve the lower part from the superincumbent weight. Near to the pyramid are heaps of broken granite, which may be the chips of the blocks for the extreme casing; the blocks themselves, probably, have been re-used in modern times, as the pyramids have been a sort of quarry for ages past. The fragments, though granite, crumble to pieces upon being handled, and are much decomposed, either from great antiquity, or from an exposure, not merely to the corroding air of the desert, but also to the moist winds of the Delta. The common saying, that it never rains in Egypt, only applies to the upper country. In the Delta, extending from the sea to the district of the pyramids, rain is frequent and copious, and it was noticed that persons have arrived at Alexandria, and remained there some time, subject to continual rain, and have left with the impression that it always rained in Egypt, although their idea before visiting the country was, that there it never rained.

The next pyramid is situate at *Rhegah.* Mr. Scoles here remarked that the names given to the pyramids, and by which they are known, are derived from the villages nearest these monuments, and have no reference to their ancient names, though frequently the site of an ancient city is to be traced in the modern name of the villages in the vicinity. This pyramid of Rhegah is curious, on account of being carried up in two inclines, like a pyramid at Dashhour. Mr. Perring did not succeed in discovering any entrance to it; but in the course of his excavation he discovered fragments of stone sculptured and colored, and some marked with golden stars upon a dark blue ground, as if belonging to the ceiling of an apartment.

At *Abouseer* are five pyramids, some tolerably perfect; Mr. Perring experienced great difficulty in exploring the interiors, as large masses of rubble masonry constantly fell in, and seriously injured

some of the explorers. The interiors of three of these pyramids are similar in their arrangement. The entrance passages leading from the centre of the northern fronts, are at first inclined, and afterwards horizontal. The apartments in the centre, range from east to west, and are covered by inclined roofs, formed of several courses of stones. The bulk of the northern building has been, in the first instance, carried up in degrees, or steps, and afterwards completed in the pyramidal form. The masonry, in general, is very rude, consisting of rough blocks of various sizes put together like rubble work with *Nile earth*, instead of mortar. The passages are lined with granite, and were closed by portcullis of granite; this material was apparently introduced to give strength to the masonry where its solidity was weakened by passages, &c., and, as an additional security, there had been three tiers of roof blocks over the chamber, and the base of the upper tier had been carried beyond those of the lower, in order to distribute the pressure over as great a base as possible. These blocks were of immense size, some 45 ft. long, 9 ft. wide, and 12 ft. thick, and yet so completely had they been destroyed by the indefatigable exertions of the people who broke into these pyramids, that only two perfect blocks, and fragments of two others remain. The marks of wedges were every way visible, but Mr. Perring observes, it is difficult to imagine any power but that of gunpowder could have effected so much destruction. A recess in the casing above the entrance appears to have been intended to receive an inscription like that, as we are informed by Diodorus, was placed over the entrance of the third pyramid of Ghizeh; and this circumstance may account for the inscription, said by Herodotus, and by other authors, to have been seen upon the great pyramids. In one of the Abouseer pyramids blocks of granite filled up the entrance passage, and remained in their original positions, clearly proving that the interior of the pyramids was not intended for any astronomical purposes. The pyramids of Ghizeh had the passages similarly filled up, and the violators of these monuments of the dead, had, in the first instances, forced a way down to the chambers through the solid masonry.

The larger of these Abouseer pyramids was built in steps, or degrees, covered over with flat stones, and the space between these and the pyramidal casing was perhaps filled up with a rubble work of smaller stones. The mortar used in this pyramid was composed of Nile earth mixed with a small quantity of lime, or pounded limestone. In this pyramid we have a specimen of the durability of wood, for a long piece of this material had been worked into the masonry, which, though rather shaky, was completely sound, and must have been built in the masonry at the time of the original erection of the building, a considerable portion of the same still remaining inclosed among the stones that have not been disturbed, and the mortar adhering to its surface, which could only have taken place when it was first laid on. A portion of this very piece of wood is in the British Museum. In the smaller pyramid the apartment was 12 ft. 2 ins. long, and 10 ft. 6 ins. wide; the roof was covered with blocks laid horizontally, and which had given way.

At Sakkarah are eleven pyramids, and a large building called the Throne of Pharaoh. They are built of stone, and are much decayed, except the large one, which is built in degrees, and this and another towards the north-east are the only two at present open. Mr. Perring has given a sketch of these pyramids, and that gentleman remarks, that Bruce probably alluded to this view, when he observed that "the traveler is lost in the immense expanse of desert, which he sees full of pyramids before him—is struck with terror at the unusual scene of vastness, and shrinks from attempting any new discovery among the moving sands of Sakkarah." In the second pyramid the regular inclined passage in the centre of the northern front remains closed up with masonry. The two apartments have pointed roofs, the blocks which form the sides are not laid in horizontal beds, but are laid on an inclined plane like the beds of the queen's chamber in the great pyramid of Ghizeh.

The great pyramid of Sakkarah is called, by the Arabs, Haram el Modarrggeh, "The Pyramid of Degrees." It is evident that the exterior of the edifice originally consisted of six degrees, or stories, varying in height, and gradually diminishing in height towards the top, each of which had the shape of a truncated pyramid, and was successively smaller than that below it; but by the effect of time and violence, the whole of the eastern, and nearly the whole of the northern and of the southern sides of the lowest tier have been removed. Two attempts have also been made to force an entrance on the southern side, and the French are said to have employed artillery for the purpose. The bulk of the masonry consists of loose rubble work, and is inclosed by walls about 9 feet in thickness, and are composed of rudely squared stones set to the angle of the face; and the breadth of the building from north to south, has, apparently, been increased by an additional wall on each of these sides. The walls of the lowest tier are 10 feet thick. The mortar is of various kinds, but it is principally composed of the gravel of the desert, and of lime, or of Nile earth, and of small pieces of calcareous stone. The face of each story has an angle of 73° 30′ with the horizon. The entrance is in a pit which opens into a passage partly horizontal, and partly inclined, leading to the lower part of the large apartment. Near the entrance of the passage is a hole for the pivot of a door. Another passage from the northern front leads to the same apartment at 7 ft. 6 inches above the floor. A third entrance from the same front communicates with a recess in the upper part of the apartment. A fourth entrance proceeding from a pit on the southern side, communicates by a horizontal gallery with another recess 70 feet above the floor of the apartment. The gallery is an excavation, but as the rock above it was not of sufficient thickness to sustain the weight of the superincumbent masonry, the ceiling is supported by a row of 22 short columns formed with blocks of compact limestone. The columns have been brought to their bearings by wedges of wood. The southern end of this gallery did not seem to have been previously visited, as nearly 30 mummies were found in it apparently undisturbed. They had neither coffins, or sarcophagi, but three, or four, had painted decorations;

they were enclosed in wrappers with pitch and bitumen: but as Mr. Perring did not meet with any of the objects usually deposited with mummies, excepting some of the common stone idols on the body of a female, he, therefore, concluded they were the bodies of persons employed on the building.

A large apartment, measuring 24 feet by 23 feet, and 77 feet high, is an excavation. The original ceiling was examined by the help of torches made of greased rags, and ascertained to have been formed with planks, supported by a platform of timber, consisting of cross bearers of oak, larch, and cedar, and of two principal beams of oak about 18 by 12, and strutted from each side by angle pieces. The larch was in the soundest state. Beneath the floor of this large apartment, which consists of blocks of granite 3 ft. 6 ins. to 4 ft. 6 ins. in thickness, a remarkable chamber 10 ft. long, 5 ft. 4 ins. wide, and 5 ft. 4 ins. high had been formed; the entrance to it had been closed by a conical block of granite shaped like the stopper of a bottle, above four tons weight.

The Baron von Minutoli supposes this chamber to have been the place of an oracle; but Mr. Perring is of opinion the place was intended for a treasury, because there did not appear any secret entrance by which a man could easily have got into it, and because the ponderous block by which it was closed did not seem fitted for mysterious purposes, as a number of men, and machinery also, would be required to raise it; because, likewise, no acoustic effect was perceived which would peculiarly qualify the place for an oracle.

The floor of the large apartment was supported by pillars of loose masonry wedged up with wood to an uniform height; broken pieces of wood, crooked branches, &c., have been inserted between the pillars to tie them together. The extensive employment of wood is peculiar to this pyramid. There are other smaller apartments in this pyramid. The doorway in one of them is bordered with hieroglyphics in relief, and small stars in relief are sculptured on the headings of this and another doorway.

The sides of some of the apartments are ornamented with rows of convex pieces of bluish-green porcelain about 6 inches by 4½ inches, inscribed on the back with a hieroglyphic, the impression of which remained on the cement. The porcelain had been removed. At the back of each piece of porcelain was a projection pierced through with a hole, into which the moist stucco upon the wall entered, (the stucco was composed principally of plaster of Paris,) in some instances, to increase the adhesion, the wall was also perforated in the same manner. This pyramid differs from the rest in many respects. It is the only one in Egypt the sides of which do not exactly face the cardinal points, the northern front being 4° 35′ east of the true north. It differs in the form and mode of building, in the number and complexity of the passages and apartments, having four entrances, one being on the southern side; by the hieroglyphics, and peculiar ornaments on the walls of the chambers, and also in containing a large apartment covered with timber. The remaining pyramids at Sakkarah are very much ruined, and have not any peculiar arrangements, or con-

struction, to require particular notice. The Throne of Pharaoh, so called from an Arabian tradition that an ancient king of Egypt erected it for his seat, is a pyramidal building, composed of very large stones, and constructed in two degrees, or stories. The materials consist of coarse calcareous stones, in which are semi-petrified oyster shells. The building, has, no doubt, been a tomb, but no entrance has been discovered.

At Dashhour are three pyramids of stone, and two of crude brick. The north stone pyramid is the most perfect of any in this district. The stones are laid in horizontal courses, and the masonry is good; the angle at the apex is nearly a right angle, and the building has, on that account, a handsome and solid appearance. The usual inclined passage leads to the chambers about 12 ft. wide, which are covered over by the courses of the walls over sailing about 6 ins. on each side, leaving the ceiling 1 ft. 2 ins. in width.

The southern stone pyramid is built in two inclinations, so that the lower part has the form of a truncated, and the upper that of a perfect pyramid, which mode of construction, according to Sir Gardner Wilkinson, was probably occasioned by a desire to complete the building more quickly than it was first intended: this conjecture was, in some degree, confirmed by Mr. Perring's researches, by which it appeared that the upper part had been carried up with less care than the lower, and was also composed of smaller stones; but whatever may have been the cause, all architects must agree with Mr. Perring, that the effect is unpleasant, and very inferior to that of the other regular formed pyramids. The beds of the casing stones are not horizontal, but incline downwards towards the interior of the edifice, in order, probably, to obtain greater solidity, as likewise to save the materials, as less of the external faces of the stones thus laid would require to be worked away to complete the exterior of the building. This inclination, however, is not uniform, nor at right angles to the exterior, but it seems to be regulated by the shape of the blocks. The usual inclined passage leads to several chambers, which are covered by the side courses approaching each other.

The northern brick pyramid is composed of crude bricks 16 ins. long, 8 ins. wide, and from 4½ ins. to 5½ ins. thick, some composed of alluvial soil, some of sandy loam mixed up with Nile earth, and a little straw. All the bricks are remarkably solid, laid principally in courses from north to south, occasionally intersected by courses from east to west. The bricks were bedded in, and the interstices between them were filled in with fine dry sand. The bricks were marked on the upper surface, by means of the fingers, with different signs, apparently according to their quality, and also according to their position. The most usual mark had been made by two fingers about 1 inch apart, having been drawn down the middle. This building was cased with stone, and it was supposed that stone might have been also employed in their interior for the construction of the apartments, or that the interior might afford additional proof of the antiquity of the arch, because ceilings to any extent could not have been formed with bricks in any other manner; but with all Mr. Perring's excavations and researches, he could not discover any entrance, or apartments,

within, but he discovered a very curious and interesting mode of forming a foundation. It seems that the stony surface of the desert had been made level by a layer of fine sand, and confined on all sides by a stone platform 14 ft. 6 ins. wide, and 2 ft. 9 ins. thick, which supported the external casing, and the pyramid was built upon the sand, which is firm and solid. Mr. Perring has met with many other instances in Egypt where sand had been thus used, and, provided it be retained in its place, it apparently may be depended upon. The blocks composing the platform were laid upon four courses of bricks. Several of the blocks of the casing were held together by stone cramps of the double wedge form.

According to Herodotus, Asychis, the successor of Myserinus, added lofty propylæa to the eastern front of the temple of Vulcan, and from a desire to surpass his predecessors, constructed a pyramid with bricks, upon which was this inscription—"Do not degrade me by comparing me with the pyramids built with stone, which I excel as much as Jupiter excels the other gods, for those who built me thrust poles into the lakes, and, collecting together the mud which adhered to them, they made bricks, and thus they constructed me." The pyramid in question has been supposed by Mr. Hamilton, and by other good authorities, to have been built by Asychis: and in support of that opinion it may be observed that it is the most considerable pyramid built with bricks, and that it is near the other pyramids built with stone, with which it might have been compared, and also that it is within a short distance of the Temple of Vulcan, which Asychis had so considerably embellished: the solidity of its construction is likewise remarkable, not a single brick appears to have settled from its place; and, although the boasting terms of the inscription has excited much surprise, it is difficult to imagine a mass more solid, and also more durable, as long as it was protected by an external casing of stone from the effects of the atmosphere. It is certainly, therefore, as superior to those built with common stone rubble, as Jupiter may have been supposed to the other gods. As the whole of the bricks are not composed of alluvial soil, the latter part of the inscription can only refer to those formed of the mud, or clay, drawn out of one of the sacred lakes. If it be urged that this pyramid could not have been built by Asychis, because from having been cased it must have had the appearance of stone, it may be remarked, that all the brick pyramids in Egypt (which are four) appear to have been covered with stone; and likewise that the above mentioned inscription would have been unnecessary had the material, of which the pyramid was formed, been apparent.

The southern brick pyramid is much destroyed, and Mr. Perring did not discover any traces of the chamber, the roof of which is stated by Dr. Richardson and others, to have fallen in, nor did he perceive any considerable settlement. It is built in the same manner, but not so carefully, as the other brick pyramids. The bricks contain a greater quantity of straw, and vary from 15¾ ins. to 13½ ins. long, and 7½ ins. to 6½ ins. wide, and 5½ ins. to 4½ ins. thick. The upper surfaces have been marked with the fingers. Civ. Eng. & Arch. Journ.

To be Continued.

Atmospheric Railway—Working Expenses compared with those of ordinary Railways using Locomotive Power. By J. Herapath.

We have here entered upon ground altogether unbroken and unknown to practical men. The damage that is done by locomotives to the roads, though evidently more than the carriages, is, to the best of my knowledge, unknown apart from the trains. We cannot tell whether the engine injures the road in proportion to its weight, or in a higher ratio. Neither can we say what would be the cost of keeping the atmospheric piston, main, &c., in repair, for we have had literally no experience of it. No doubt exists in my mind but that many little items of expense will occur, of which we have, at present, no conception. Among these will be keeping the joints of the main tight, which is generally a troublesome thing even in water and gas pipes, where no force, or jostling, whatever is experienced at all comparable with that upon the atmospheric railway. Keeping the main in gage, if I may so express myself, with the rails, will be another element of expense. The maintenance of the valve they may form some idea of from the experience they have had, though they want the trial of a hard winter, to test both its efficiency and the expense of its maintenance. Other items will, doubtless, make their appearance in due course, but at present they are altogether so out of the range of our knowledge, that I do not see how we are to estimate them. I, therefore, propose to set off such things, as we cannot estimate against the wear of the road by the locomotives, (except the wages of two men to attend to the main,) which will, in all probability, be much in favor of the atmospheric.

Another great difficulty we have in comparing the working expenses of the atmospheric plan with the locomotive, is the not being able to reduce the expenses to particular units, as, for example, to tons per mile; for the atmospheric advocates may say, "it is true ours cost so much more according to this mode of comparison, but we could do double business at little, or no, increase of expense, as we are always obliged to keep our fires up, our engines going, and our mains exhausted, to be ready for contingencies whether we have trains, or not, whereas you can lower your power nearly in proportion to the work you have to do." There is much truth in this, but it tells the other way too, as it shows the greater convenience, and superior adaptation of the locomotive system to circumstances.

Besides I apprehend we must not set up an imaginary business, nor argue from what might be done, but take things as they are, and deduce our expenses from what is to be done, not from what may under ideal circumstances be done. I propose, therefore, to take one or more lines with the trade existing on them, and institute a comparison between the working expenses of their locomotive power, and those of the atmospheric, if applied to do the same work on the same lines. But as in this there might be some disadvantage to the atmospheric by particular selections, owing to there not being sufficient business on the line, I shall choose two to which I think it is

impossible on that, or any other, score to make an objection, namely, the Great Western, and the London and Birmingham. Both of these lines are of a length, which would be a decisive test, possess each a trade of the first magnitude, and a laudable emulation in their managements to rival each other.

Divide their loads how they may, I think it will be allowed that a less powerful apparatus than that at Dalkey could not work either of these lines. Indeed, I should rather be inclined to doubt whether the Dalkey instruments would be sufficiently powerful for either of them. For the Great Western I firmly believe they would not. However, we will strain a point, and grant that they would.

On the Great Western the locomotive expenses for the year 1843, as per reports, have been,

	£	*s.*	*d.*
Half year ending June 30, ...	33,402	19	5
" " December 31, . .	33,393	14	0
Total for 1843, . . .	66,796	13	5

which includes coke for stationary engines, rates, taxes, and gas, and every other expense connected with it. For four months of the year they worked 181 miles, and for the remaining eight 190. We may, therefore, reckon 187 miles as the average run for the year, which will give better than £357 per mile per annum. Now the Great Western is a line on which it has been alleged that 18 miles of it, that is the Cheltenham part, have been worked at a loss. Had the whole, therefore, been equally profitable the per mile locomotive power, as respects the traffic receipts, would have been less.

On the London and Birmingham Railway the cost of locomotive power for the main line, 112¼ miles, deducting the Camdentown part, 1½ mile, worked by a stationary engine, and without noticing the Aylesbury line, was, for 1843, as per reports,

	£	*s.*	*d.*
Half year ending June 30, ...	31,189	13	11
" " December 31, . .	32,649	10	2
Total for 1843, . . .	£63,839	4	1

or at the rate of something more than £575 per mile.

These two sums differ more than one might have expected, but their ratio is not far out of that of the receipts per mile of the two lines.

Let us now turn our attention to the working expenses of the atmospheric. It is impossible to do this with the accuracy we have the locomotive, because many items of expense in this have yet to be learned from experience, as, for example, the reparations and greasing of the valves generally, the inside coating of the mains, the repairs and renewal of the pistons, with their lifting and closing rollers, the keeping of the joints of the main tight, and the keeping of the main in gage with the rails, and every now and then supplying a new length of main, the consequence of accident, &c., &c. The warming pans we do not include, because we apprehend their proved useless-

ness will cause them to be dispensed with. Except the wages of two men to superintend and attend to the main and valve, I purpose, as I have said before, to set all this against the damage done to the road by the locomotive—a concession by which I am satisfied the atmospheric system will be a considerable gainer.

Our calculation gives a much higher value—nearly double—for horse-power of the engine than theirs, but we will take it at their own estimate, that is at 100 horse-power, and their own statement 5 lbs. per horse-power per hour for the coals consumed, and we shall then have 500 lbs. per hour for the consumption. Now if the atmospheric railway was to be applied to either of the two great lines previously mentioned, and to carry the mails, their fires had need to be kept up nearly the 24 hours round. At all events they must be kept going the 17 hours now worked by both of these lines. Then we shall have 8,500 lbs., or 3.80 tons, per day. Supposing this costs 10*s.* per ton, and I hardly think we could get it here for less, we have £1.90 per diem, or £693 10*s.* per annum, for the cost of fuel. Hence the following estimate:—

Estimate for 1½ mile per annum of Atmospheric.

Coals, ...	£693 10*s.*
Repairs of engine and machinery, including fire-bars, boilers, hemp, oil, &c., at £1 per h. p. per annum,*	100 00
	£793 10
One engineer, one stoker, and two men for looking after the 1½ mile main and valve at £6 10*s.* per week,† .	£338 00
	£1,131 10
And per mile per annum, ...	£754 7
Add interest on £11,000 extra cost, at 5 per cent.,‡ .	550 0
Total per mile, ...	£1,304 7

Thus we have, in round numbers, £1,300 by the atmospheric, to do what is now done by locomotives on the Great Western for £357, and on the London and Birmingham for £575.

Lond. Railway Mag.

Utility of Wire Ropes.

The question of the comparative strength of hemp and wire ropes used in the "winning" of coal, and, indeed, for every other purpose for which rope is applicable, having been frequently discussed in our columns, we have pleasure in complying with the request of a correspondent, by inserting the following communication, addressed to Mr. Newall, manufacturer of wire rope, by so distinguished a colliery viewer as Mr. Matthew Liddell, dated from Benton Grange:—"Dear Sir, I consider the following information may be interesting, and cer-

* Wood's Practical Treatise on Railroads, p. 755, 3rd ed.
† The London and Birmingham expense at Camdentown.
‡ In such property the interest ought to be at least 7 per cent.

tainly goes far to establish confidence in the equal security of flat wire ropes with those made from hemp, when exposed to a sudden violent strain; which, it has been stated, would cause the former to snap, or break. On Monday last, when employed in drawing coals, the breaksman of the engine, (45 horse power) on which a pair of your flat wire ropes were put in June last, neglected to check the engine on the approach of the cage and tubs to the surface; and, consequently, the engine continued at full speed, (the rope moving about 120 fathoms a minute,) until suddenly stopped by the cage coming into violent contact with the pulley. The shock slightly displaced the pulley frame, when the rivets of the shackle which you attach to the end of the rope where the cage is hung on to it, were drawn through the strands of the rope, and the cage and coals fell on the "keeps" at the top of the pit, which prevented their falling down the pit, so that the damage done was trifling. I have since then had the wire rope examined, and, although the strain on it must have been very great to stop the engine, yet it does not appear to have sustained any injury, and is, apparently, as good as when it was first put on.

MATTHEW LIDDELL."

Lond. Ming. Journ.

Description of a Machine for Raising and Lowering Miners. *By* JOHN TAYLOR, M. Inst. C. E.

The author states that the great depth to which the copper and tin mines, in Cornwall, and in Germany, had been worked, had drawn simultaneously, in the two countries, the attention of engineers to some mode of facilitating the ascent and descent of the miners, whose strength was exhausted, and their health seriously affected, by the fatigue of going to, and returning from, the scene of their labors, by nearly vertical ladders, as the men could not be raised and lowered by the rope of the winding engines, as in the coal districts. The Polytechnic Society of Cornwall offered premiums for machines for effecting this object, and in 1834, three prizes were respectively awarded to Mr. Michael Loam, Capt. W. Nicholas, and Capt. W. Richards, for plans, the two first of which embraced the principle which has since been adopted with modifications, both in Germany and in Cornwall. A premium was also offered by Mr. Tremayne, for any new method, or for the most available improvement on the former plans, and was awarded in 1838 to Mr. John Philips, for a method, differing, however, from that which has been put in practice. About this time it was ascertained that a machine, somewhat similar to that designed by Mr. Michael Loam, had been applied with success to one of the deepest mines in the Hartz; and drawings, with a description, were published in the report of the Polytechnic Society in 1838. Mr. Charles Fox also commenced a subscription, for the purpose of awarding a sum of money to any proprietor of mines who would first bring into active operation efficient machinery, adapted for the purpose in question.

At length, the adventurers of the Tresavean copper mines, undertook to erect a machine from the designs, and under the superinten-

dence of Mr. Michael Loam; it was first used for a depth of 27 fathoms, on the 5th of January, 1842, has since been extended to 264 fathoms, and it is now contemplated to carry it to the lowest part of the mines, which is 288 fathoms deep.

The machine, which is worked by a steam engine with a cylinder of 36 inches diameter, consists of two rods, to which are attached, at intervals of 6 feet throughout their length, platforms, upon which the men stand; these rods receive an alternating motion from two cranks, which give them a stroke of 12 feet; the men, either in ascending, or descending, step from one platform to the other, as the rods remain, for an instant, almost stationary, when the cranks are going over the top and bottom centres; and, as the platforms are half the length of the stroke apart, one set of men can ascend while another set is descending, without at all interfering with each other. Each rod makes three strokes per minute; and when once the platforms are filled with men, they are landed at the rate of six men per minute, either going up, or down; the speed of traveling being about 72 feet per minute, or 240 fathoms in 20 minutes. By the ordinary mode of ascending by ladders, it would have occupied 48 minutes to mount from the same depth, as the usual speed is about 30 feet per minute, so that more than 50 per cent. of time is saved, independent of the diminution of fatigue.

The rods at the Tresavean mine act vertically for the first seventy fathoms, below which they follow the direction of the vein, diverging from the perpendicular from six inches to eighteen inches in six feet. The action of the apparatus is stated to be perfectly successful; no accident has occurred in the use of it, and the miners are convinced of the safety, as well as the ease, afforded by it.

Lond. Journ. Arts & Sciences.

Blasting by Electricity.

A very interesting display of engineering skill took place at Knockmaroon hill, in the Phœnix Park, Dublin. A huge mound of earth covering a quarry, had been perforated with nine chambers, in which two tons' weight of gunpowder had been so distributed, as, by the application of the galvanic battery, to be exploded at once. The operation was conducted under the superintendence of Capt. Larcom, of the Royal Engineers, and, at a little after three o'clock, every thing being in preparation, and all due precaution being taken to prevent accidents, the explosion took place without any very alarming noise, the vast mound of earth rising, wave like, about three, or four, feet, and then rolling over in a dense mass into the hollow underneath. The object of the experiment, which was completely successful, was for the purpose of cutting away a high precipice, so as to form an inclined level with the road, or pathway, below it. About twenty feet of the park wall close to the embankment, gave way from the effects of the concussion, but no other casualty occurred.

Mechanics' Mag.

Proceedings of the Institute of Civil Engineers.—From the London Athenæum.

Slips in Cuttings and Embankments of Railways—April 2.—Some observations were made by Sir H. T. De la Beche, the Rev. Mr. Clutterbuck, and several members, on the geological features of the slips, whether occurring naturally in cliffs, as at the back of the Isle of Wight, or in the artificial cuttings of railways. It was contended, that, in both cases, the reduction of the lower and softer beds to the state of mud, by percolated water, rendered them incapable of bearing the weight of the superincumbent strata, and that the mass, when saturated, slid down by its own gravity; but that slips in railway work were accelerated by the vibration caused by the passage of the trains. The vibration of the air from the discharge of a gun, had been known to cause an avalanche; and the cases were almost analogous. More attention, both to surface and bottom drainage of the slopes, was much insisted upon; and it was urged, that the back drains, so close to the top of the cuttings, were prejudicial; that in the dry season the bottoms cracked, the rain found its way through, and it had been frequently noticed that the slips commenced at a few feet below the level of these drains. The dry shafts which had been sunk in the slopes of the Eastern Counties Railway, by Mr. Braithwaithe, with the concurrence of Sir H. T. De la Beche, were instanced as successful in rendering wet and treacherous strata comparatively dry and secure. A section was exhibited of the embankment at Hanwell, on the Great Western Railway; this embankment, which was of gravel, was fifty-four feet high; it was laid in a marshy valley traversed by the river Brent; the London clay, upon which it was laid, inclined towards the river, and at one of the numerous fissures with which that stratum abounds, a subsidence occurred squeezing up, at the same time, on the lower side, to as great an extent as the embankment sunk, which was stated to be nearly as much in one year as the entire mass of the embankment. This subsidence was stopped by loading the foot of the slope, and thus restoring equilibrium, and it was stated to be at present quite secure. It was urged that, in the earthwork of canals, where there was no vibration, the slips generally occurred in the first few months after the formation of the embankments; but that, on railways, they occurred quite as frequently after the lapse of several years. It appeared, therefore, that much was due to vibration.

Account of the Railway from Amsterdam to Rotterdam.—April 16.—This railway, which is the first that has been constructed in Holland, was commenced under adverse circumstances, and the works languished until the appointment of the author (Chevalier F. W. Conrad,) as the engineer director, when it appears, that although, from the defective state of the law of expropriation, great difficulty was experienced in obtaining possession of the land for the railway, the works were carried forward so vigorously, that the four divisions of the railway, extending from Amsterdam to the Hague, were com-

pleted between March 1839, and December, 1843, leaving only the fifth division between the Hague and Rotterdam, to finish the line, and of that the works were proceeding rapidly. The length of the line, when the whole is finished, will be about 52¼ English miles, and the cost of the single line of rails laid is about £1475 per mile. The detail was given of all the conditions of the contracts, the prices and quantities of materials, the method of execution, the forms and dimensions of the buildings, of the bridges, some of which are of cast-iron, large sized, and very ingeniously contrived for opening, for the facility of the navigation; *the iron beams of one of these bridges were seventy-three feet long, cast in one piece.* Other bridges of timber, on the American trellis-work principle, and of very large span, were also described. The mode of construction of the permanent earth work was then described: almost the whole line, being through marshy ground, was laid upon fascines, and in some places it was carried entirely by these means through water of considerable depth. An ingenious mode of cutting off the heads of the piles under water was then described, and it was thought that its simplicity would induce its introduction into the English engineering works. All the other particulars of the railway works were given in the most minute detail, with tabular statements of the number of passengers conveyed, the receipts, the number of miles traversed by the locomotive engines; and the paper was illustrated by a large collection of maps, sections of the line, and drawings of the construction of all the bridges and other works of the line.

ENGLISH PATENTS.

Specification of a Patent granted to CHARLES KÖBER, *of Leeds, in the county of York, for improvements in Fixing Color in Cloth.—Sealed 7th March*, 1840.

This invention consists, firstly, in the use of bichromate of potash, as a medium for uniting the coloring ingredients, used in dyeing, with the wool, whereby a faster, brighter, and cheaper color is obtained, and is more effectually fixed in the cloth than by using the mordants generally employed, such as sulphate of iron, and sulphate of alumina and potash, or, as they are commonly called, copperas and alum.

In consequence of the great affinity of bichromate of potash to the wool, as well as to the coloring ingredients, a comparatively small quantity of it will fix the dye-wares; that is to say, one pound of bichromate of potash can be used instead of from three to four pounds of alum, or copperas; besides which, the color produced by the use of bichromate of potash is fast in alkalis and air, and better resists the operations of scouring, and the milling process employed in the manufacturing of cloth; and less coloring ingredients are required to be used than by the ordinary mode, because the color, produced thereby, being faster, no loss of color will take place when scouring the cloth

with soap; and the fibres of the wool, in the dyeing of which bichromate of potash is employed, will not be injured, as they have hitherto been, by the acids contained in alum, or copperas; and, on the contrary, the cloth will be softer, and easier to be scribbled and milled; and, consequently, the same quantity of wool will produce a greater and better quantity and quality of cloth than by the method usually employed.

The ordinary coloring ingredients are employed in conjunction with the bichromate of potash; and as every different shade and color requires a different proportion of ingredients, and the dye-wares differ so much in quality, that sometimes a double quantity of them is required, it is impossible to state the different proportions in which the bichromate should be used with them, the requisite amount varying according to the quantity of ingredients to be fixed in the wool; but the patentee generally employs three pounds of bichromate of potash for preparing one hundred pounds of scoured wool; and he sometimes adds two pounds of argal, or tartar. In the liquor, thus produced, the wool is boiled for one hour and a half; and on the next day the color is filled up with as much of the coloring ingredients as the desired shade may require.

The second improvement consists in obtaining green colors perfectly fast in acids, alkalis, and air, by dyeing the wool blue, and then manufacturing the cloth from the blue wool, so as to make it what is called partly finished cloth, with a white, or colored, list, and then adding the yellow wares, or ingredients, to the cloth, instead of to the wool; by which means a perfectly fast green color will be obtained, similar in appearance to wool-dyed green, but much faster. Every kind of yellow ware may be used, but fustic is preferred; and in order to fasten the color, hydrochloric acid, saturated with tin, is used, to which is added as much water as will give the solution a specific gravity of 1.2612, or 30° Baumé; and of this solution from six to seven pounds is used for every one hundred pounds of cloth, besides the usual quantity of alum and argal. This solution could not be applied to wool in fleeces, as it would be destructive to the use of soap, and, consequently, to the milling process.

The last part of this invention consists in the use of soda and bran for dissolving the indigo in the vats for dyeing blue, whereby the indigo is better fixed in the wool, and at a less expense than is incurred by the use of woad, madder, and bran, which are usually employed for that purpose.

The soda is employed in the following manner:—In a seven feet vat the water is heated to 125° Fahrenheit, and sixty-five pounds of bran, thirty-five pounds of common soda, (which has about 23 per cent. of carbonate of soda,) and four pounds of indigo, are thrown into it, together with the same quantity of lime as is usual for woad vats. The vat is worked from 110° to 118° Fahr., three, or four, times during the day without stirring; and in the evening the vat is heated to a temperature of 125°, and into it is thrown about four pounds of lime, six pounds of bran, and five pounds of soda, with such an additional quantity of indigo as may be required for the following day;

after this addition the vat is stirred as usual. If the vat has been working during the day, the above quantity of lime, bran, and soda, is added every evening, together with the requisite quantity of indigo. It would be difficult to state the exact quantity of indigo required, as any amount, from half a pound to twenty-five pounds, may be added, according to the shade of color required to be produced the following day. After proceeding in this manner for eight, or ten, weeks, the sediment is removed, and, with the liquor in the old vat, the operator sets a new vat, adding thirteen pounds of bran, and ten pounds of soda, with as much lime and indigo as may be required. The use of lime being to check the fermentation produced by the bran, it is impossible to state the exact quantity which may be required; but enough is used to check the fermentation in the vat to such a degree as will be sufficient to deprive the indigo of its oxygen, without an immoderate fermentation, which is very prejudicial. The vat, in which the soda is used, must be perfectly yellow; that is to say, the indigo must be perfectly deprived of its oxygen, or, as it is generally termed, the indigo must be "sprung," in which case the vat appears yellow. By the use of soda ashes, (which have about 46 per cent. of carbonate of soda,) instead of common soda, half the quantity will produce the same effect. Pearlash may likewise be employed, if the price will admit of it; and fine sharps may be used instead of bran.

The claims made by the patentee are, first, the use of bichromate of potash as a substitute for copperas, alum, and other mordants; secondly, the production of perfectly fast green colors, by dyeing the wool blue, and adding the yellow ingredients after it has been manufactured into cloth; thirdly, the use and application to indigo of soda and bran, or soda ashes and bran, either by themselves, or mixed with woad and madder, whereby the color is fixed in the wool better and cheaper than by the use of woad and madder alone.—[Enrolled in the Enrolment Office, September, 1840.]

Lond. Journ. Arts & Sciences.

Specification of a Patent granted to Joseph Daniel Davidge, *for Improvements in manufacturing certain materials as substitutes for Whalebone, applicable to various useful purposes, and in the machinery for effecting the same.—Sealed 24th July,* 1843.

These improvements consist in the application of strips of metal, either rolled, drawn, or twisted, into tubular forms, for various purposes to which whalebone is now applied; and also in suitable machinery for forming the same into tubes.

The advantages to be derived from the application of twisted strips of metal, or metal tubes, over the use of whalebone, are elasticity, durability, lightness, and economy; and the principal objects to which they may be applied, are riding and other elastic whips; whip-stems, as intermediate pieces between the thong and the handle; umbrellas and parasols, as the framing over which the cotton, silk, or other fabric, is distended; stems for feathers, walking-sticks, fishing-rods,

and ramrods; the flexible stems of brushes, or apparatus, for sweeping flues, or chimneys; as substitutes for the pieces of whalebone, or cane, employed for stiffening the caps worn by boys and men, and a variety of other useful purposes.

Various modes of forming the tubes, either by twisting, rolling, or drawing, the strips of metal, and a variety of mechanical contrivances for effecting these objects, may be suggested; but the method preferred by the patentee, is forming the tubes of strips of metal, by twisting the said strips helically, or conically, round a mandril, in the following manner:—Sheet metal for forming the tube is cut into strips of the desired breadth, according to the stiffness intended to be given to the tube, and these strips are then twisted round a mandril. They are afterwards drawn several times through "draw-plates," in order to bring them to the required diameter; they may be passed through one, two, or more, pairs of grooved rollers, and by altering the shape of the grooves therein, the tubes can be made to assume a circular, oval, square, or any other desired form. When this operation of drawing, or rolling, has been effected, the helical twists are in a compressed state, and only show a space between them, when the tube is bent out of a straight line. The tube is then hardened and tempered, great care being taken to keep it straight, and, if required, it may be turned and polished in a lathe, or ornamented in any other manner. It should be remarked, that the length of the strip of metal must be according to the length of the tube required, as no joining of the strip of metal can be effected, either during the operation of making the coil, or afterwards; and the circumference of the mandril must not be less than the breadth of the strip of metal intended to be used.

The patentee claims, as his invention, "drawing, rolling, or twisting, strips of metal, by any convenient means, into the forms of tubes, or rods, to be applied to the purposes above mentioned."—[Enrolled in the Petty Bag Office, January, 1844.]

Ibid.

MECHANICS, PHYSICS, AND CHEMISTRY.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

On Belts: *from Morin's "Aide Mémoire de Mecanique Patique."* Translated by* Ellwood Morris, C. E.

For transmiting the motion of one revolving axis to another at a distance, we frequently employ belts of black dressed leather, passing over pulleys, or drums.

* It is well known to machinists and engineers that at the present day in many of our cotton, and other mills—especially where fast speeds are required—all the principal motions are communicated through belts.

Some of the heaviest cotton mills in this country are now (and for many years have been,) driven entirely by belts of a foot, or more, in breadth, impelled at high velocities, by large

Theory and practice show,

1. That when these belts are properly bent they do not slip, and they transmit velocity, in a constant ratio, inverse to that of the diameters of the drums.

2. That in transmiting motion from one axis to another by endless cords, or belts, the sum of the tensions of the two parts remains constant, so that when the tight, or conducting, side stretches, the slack, or conducted, side relaxes the same quantity, and that the sum of the tensions of the two sides is the same as when the machine is not in motion.

3. That the resistance of belts to slipping is independent of their breadth, and that there is no advantage in augmenting this dimension beyond what is necessary to enable the belt to resist the strain which it is to transmit.

4. That the effort S, necessary to make a belt slip upon a drum, of which the tension is t, or a cord on the throat of a pulley, is given by the formula

$$\text{Log. } S = \log. t + 0.434 f \frac{S}{R},$$

an expression in which the logarithms are those of the tables, and where we represent by f . . . the ratio of friction to pressure for belts and drums, and of which the value should be taken from experiment equal to 0.47; for belts in their ordinary state of unctousness on drums of wood; 0.50 for new belts on drums of wood; 0.28 for belts in their ordinary state of unctiousness, on cast-iron pullies; 0.38 for wet belts on pullies of cast-iron; 0.50 for cords of hemp on drums, or pullies, of wood; S . . . . the arc of the circumference embraced on the drum, or pulley; R . . . . the radius of the drum, or pulley.

The preceding formula becomes the following rule:

For calculating the tension which the tight, or conducting, side of a cord, or belt, wrapped upon a drum, should have to make the slack side slip under a given tension. Multiply the ratio of the arc embraced to the radius of the drum by 0.434 times the ratio of the friction to the pressure; add the product to the logarithm of the given tension of the slack, or conducted, side. The sum will be the logarithm of the tension sought.

Note.—This rule shows that it is useless to augment excessively the diameter of drums, with the view of preventing belts from slipping.

drums geared to the water-wheels, and made to move so fast at their peripheries as to give to the belts a speed of 1500, or 2000 feet, in a minute.

A broad belt, moving at a high velocity, is capable of transmitting a prodigious power with greater economy and convenience, in many cases, than gearing.

With proper tighteners they have been very successfully applied to saw mills—indeed, even at a low velocity, belts have been made to drive fulling stocks, one of the most desultory motions in mechanics—in fact, their great utility is so well known to all who are conversant with machinery, as to need no comment. They have, however, been generally employed very much at random, and without previous calculations.

The above essay of M. Morin supplies a desideratum long wanted here, and the writer having derived much advantage from it, in computing the powers and widths of belts, has translated it, with the hope that it may prove valuable to the mechanical readers of this journal. E. M.

Example.—What ought to be the tension of the tight side of a leather belt which embraces the semi-circumference of a wooden drum of 0.35 metres radius, in order to make the slack side slip under a tension of 50 kilogrammes?

The formula gives

$$\text{Log. } S = \log. 50 + 0.434 \times 0.67 \times 3.14 = 2.33947;$$

and, consequently,

$$S = 218.5 \text{ kilogrammes.}$$

Rule and Table Practical.—The preceding rule requiring the use of a table of logarithms; we have calculated the following table, which gives the value of the strain, S, capable of slipping a cord, or belt, on a pulley, or drum, when we know the tension, t, of the slack side, or the resistance to be overcome, and the ratio of the arc of the circumference embraced by this cord, or belt, to the entire circumference, commonly given by the drawings. In calling K, the ratio of the tension S, to the resistance t, we have $S = Kt$, and we have thus found the values of K, in the table.

Ratio of the arc embraced, to the entire circumference.	Value of the Ratio K.					
		Belts in their usual state.			Cords on drums, or rollers, of wood.	
	New belts on drums of wood.	On drums of wood.	On pullies of cast iron.	Wet belts on cast iron pullies.	Rough.	Polished.
0.20	1.87	1.80	1.42	1.61	1.87	1.51
0.30	2.57	2.43	1.69	2.05	2.57	1.86
0.40	3.51	3.26	2.02	2.60	3.51	2.29
0.50	4.81	4.38	2.41	3.30	4.81	2.82
0.60	6.59	5.88	2.87	4.19	6.58	3.47
0.70	9.00	7.90	3.43	5.32	9.01	4.27
0.80	12.34	10.62	4.09	6.75	12.34	5.25
0.90	16.90	14.27	4.87	8.57	16.90	6.46
1.00	23.14	19.16	5.81	10.89	23.90	7.95
1.50					111.31	22.42
2.00					535.47	63.23
2.50					2575.80	178.52

Use of this Table.—By the aid of these values it is easy to calculate the tension, capable of slipping a cord, or belt, in surmounting a given resistance, or the effort necessary to sustain and cause to descend slowly a given weight.

First Example.—What ought to be the tension of the tight side of a common belt to make the slack side slip on a wooden drum when its tension is 50 kilogrammes, the arc embraced on the surface of the drum being a semi-circle?

The table indicates for these data that the multiplier $K = 4.38$, we have then

$$S = 4.38 \times 50 \text{ kilog.} = 219 \text{ kilog.}$$

The formula previously enunciated, gives, for the same case,

$$S = 218.50 \text{ kilogrammes.}$$

Second Example.—What is the effort exerted by a cooper to sustain a pipe of wine, which, in slipping upon an inclined plane, exerts on each of the sides of the cord retaining it, a tension of 250 kilogrammes, supposing that he has made two turns of each side about a roller with a polished surface, but stopped by a catch?

The value of the multiplier is here $K = 63.23$. We have then for each side,

$$t = \frac{S}{K} = \frac{250 \text{ kilog.}}{63.23} = 3.95 \text{ kilog.}$$

or, for both sides, $= 7.90$ kilogrammes.

Observation.—We see by this last example what facility the friction of cords gives for moderating the descent of loads; but in these manœuvres it is necessary to take great care in avoiding shocks, and to operate uniformly.

Rules for establishing a transmission of Motion by Cords, or Belts.—For establishing the transmission of motion by endless cords, or belts, it is necessary, first, to determine the power which is to be transmitted to the pulley, or the drum. In dividing this by the velocity of the belt, or that which the surface of the drum is to take, we shall have the strain, Q,* which is to be transmitted by the belts, or an approximate value of the difference of the tensions of the tight and slack sides S and t; we shall have then,

$$S - t = Q.$$

We will calculate then the least value that we may give to the tension t, of the slack side, by means of the relation,

$$t = \frac{Q}{(K-1)},$$

which becomes the following rule in words:—

Rule.—Search in the table, above given, for the value of the ratio K, of the tension of the two sides, at the moment when they begin to slip, according to the state and nature of the belts and drums; from this number K, deduct unity, and by the remainder divide the strain Q, to be exerted at the circumference of the drum, to overcome the resistance.

The quotient will be the least tension that we can give to the slack side.

In this calculation, we take for Q, the greatest value that it can attain, including friction, and other forces besides the tensions S and t; and to make sure that in the accidental variations of resistance, or tension, the belt shall not slip, as well as to compensate, approximately, for the influence of the tensions on the friction of the axis, we augment by *one-tenth*, at the least, the value given for t, by the preceding rule.

Knowing t, we shall have the greatest of the two tensions,

$$S = Q + t;$$

* Thus knowing the number of horses power to be transmitted—then 33,000 lbs. at one foot per second, or 76¼ kilogrammes, moving one metre per second, × the horse power will $= P$; and $\frac{P}{v} = Q$, where v = the velocity of the belt.—*Trans.*

and, consequently, the sum of the two tensions $S+t$, of which the half will be the tension of each of the two sides when not in motion.

Example.—What ought to be the tension of the slack side of a leather belt wrapped on the semi-circumference of a cast-iron pulley 0.30 metres in diameter, the resistance to overcome at the circumference of this pulley being 35 kilogrammes?

The arc embraced by the belt, in its ordinary state, upon the cast-iron pulley, being 0.50 of the circumference, we find in the table $K=2.41$, and, consequently, the above rule gives

$$t=\frac{35 \text{ kilog.}}{2.41-1}=24.83 \text{ kilog.}$$

Adding a tenth, we carry this tension up to 27.31 kilogrammes, and the tension of the tight side will be

$$S=35.0+27.31=62.31 \text{ kilog.}$$

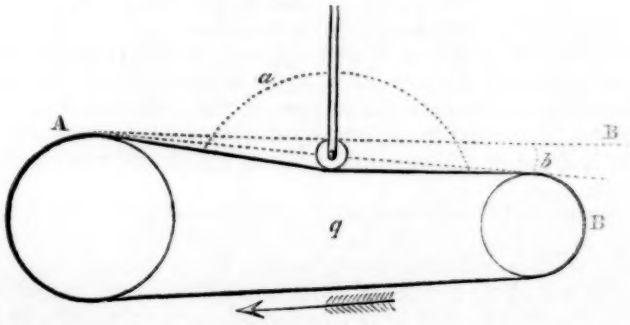
The tension natural to a state of rest, for each of the sides, will be

$$S=\frac{S+t}{2}=\frac{62.31+27.31}{2}=44.81 \text{ kilog.}$$

Of Tighteners.—In order that the natural tension of the belts may remain constant, that it may attain and not surpass the value that we have calculated, it is necessary to employ *tighteners*. We will calculate the weight, q, of these tighteners by the approximate formula,

$$q=\frac{Q\,S,\ \cos.\ a}{\cos.\ b},$$

in which a = half of the angle formed by the two parts of the belt on which it rests, or presses, which angle we can fix at will; b = the angle made by the line A B, with the horizontal.



This formula becomes the following rule:—

For calculating in the case, shown by the figure, the weight of a tightener capable of producing, by its pressure on the two sides of a belt, a given natural tension: multiply the given natural tension by twice the cosine of half the angle formed by the two parts of the belt, (at the tightener) and divide the product by the cosine of the angle made by the common tangent (A b) of the two drums with the horizontal line A B.

In this case we ought to give to the belt a length, such, that at rest it will take the flexure fixed, and the tension S, will then have very nearly the value which has been assigned to it. We reserve, moreover, by known means, the faculty of augmenting, or diminishing, at will the action of the weight of the tightener.

Note.—If, for certain dispositions of drums, the tightener cannot act vertically, we may, by a proper combination of levers, produce its action in such direction as shall be necessary, and then we calculate the effort which it ought to exert on the belt, perpendicularly to the line A B, by the above rule, supposing then the angle *b*, to be null, and its cosine equal to unity.

Example.—In the example preceding, the angle *a*, being 85°, and the inclination of the line A B, 10°, what ought to be the weight of the tightener?

The formula gives,

$$q = 89.62 \times \frac{0.0872}{0.9848} = 7.93 \text{ kilog.}$$

In conclusion, relative to belts, we will add, that we may, without any risk, and with the certainty that they will run a long time, make them support tensions of 0.25 kilogrammes per millimetre square* of section, which allows us to calculate their breadth when we know the thickness of the leather employed.

Finally, the pullies over which leather belts pass ought to have a convexity equal to about one-tenth of their breadth.

NOTE BY THE TRANSLATOR.

As an example, let us suppose—that a paper mill *rag-engine*, with a 24 inch roll, running 150 revolutions, requires 5½ horses power to drive it alone—that the motion is to be transmitted to it from a lying shaft running 70 revolutions, by means of a leather belt one-seventh of an inch thick, moved by a cast-iron polished pulley, four feet in diameter, the belt embracing half of its circumference.

Query.—The width proper for the belt. 355 lbs. $\times \frac{1}{7} = 50$ lbs. per inch wide, the strain which a belt of one-seventh of an inch thick, would safely bear.

Power. $= 33{,}000 \times 5\frac{1}{2}$ h. p. $= 176{,}000$ lbs. 1 ft. per minute $= P$.

Velocity. $= 4 \times 3.14 \times 70$ revo. $= 875$ ft. per minute $= V$.

$$K = 2.41\frac{P}{V} = \frac{176{,}000}{875} = 200 \text{ lbs.} = \text{diff. of tensions} = Q.$$

$$t = \frac{Q}{K-1} = \frac{200}{1.41} = 142 \text{ lbs., and } S = Q + t = 200 + 142 = 342 \text{ lbs.}$$

Finally, $\frac{342}{50}$ = *nearly seven inches, the width of belt required;* and 242 lbs. will be the tension of each side when the machine is at rest, supposing no tightener to be used in this case.

* = 355 lbs. per square inch of section, or for an eight inch belt one-eighth of an inch thick = 355 lbs. A millim. square = .00155 square inches.—*Trans.*

This example suffices to show how readily, by means of M. Morin's valuable formulæ, we may determine the widths of our belts by a direct process of calculation, and with a certainty of successful results where mere judgment would often fail. E. M.

To the Publishing Committee of the Journal of the Franklin Institute:—

Dear Sirs,—I observe, that in noticing an apparatus for ascertaining the specific gravities of liquids by the comparative altitudes of columns of water, and the liquid to be assayed, when reciprocally balancing each other, you refer to an apparatus upon the same principle received from Paris, by the Department of the Arts of our University nearly ten years ago.

I have sent to the Hall of the Institute an instrument, of which an engraving and description, under the name of *Litrameter*, will be found in the first volume, first series of your Journal (1826.) The same contrivance, in another form, was first made by me in 1807, or earlier: of that apparatus I have still the scale, and some other parts, in my laboratory.

The contrivance was original with me: I have never seen any similar instrument. As originally described in your Journal, a gum-elastic bag was employed to exhaust the tubes, while, by means of a cock and sliding rod, the columns were adjusted. Subsequently, I substituted a small syringe for both bag and rod. The litrameter has two scales, one for liquids heavier, the other for those lighter, than water. Yours very truly,

Robert Hare.

On the Litrameter.

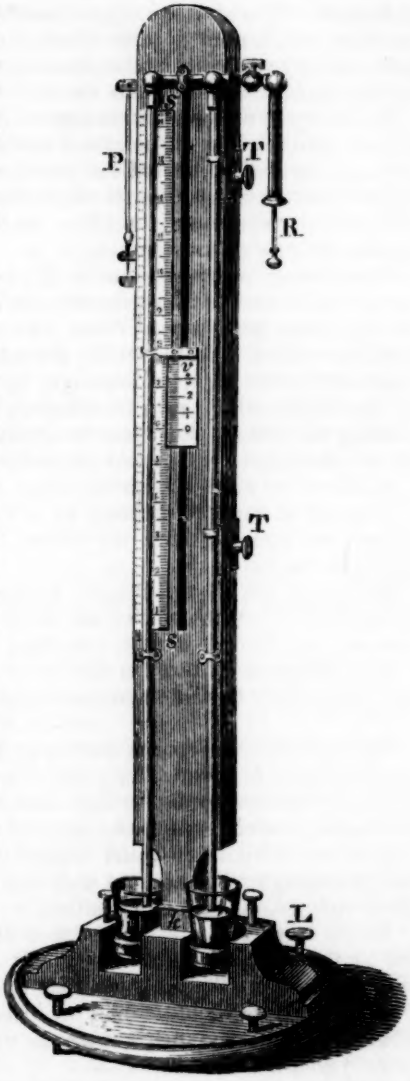
This name is derived from the Greek *litra*, weight, and *meter*, measure, and is given to one of the instruments which I have contrived for ascertaining specific gravities. The litrameter owes its efficiency to the principle, that when columns of different liquids are elevated by the same pressure, their heights must be inversely as their gravities.

Two glass tubes, of the size and bore usually employed in barometers, are made to communicate internally with each other, and with a gum elastic bag, G, by means of a brass tube and two sockets of the same metal, into which they are severally inserted. The brass tube terminates in a cock, to which the neck of the bag is tied. Between the cock and the glass tubes, there is a tube at right angles to, and opening into, that which connects them. At the lower end of this tube a small copper rod, R, enters through a collar of leathers.

The tubes are placed vertically, in grooves, against an upright strip of wood, tenanted into a pedestal of the same material. Parallel to one of the grooves, in which the tubes are situated, a strip of brass is fastened, and graduated so that each degree may be about equal to $\frac{1}{220}$ of the whole height of the tubes. The brass plate is long enough

to admit of about 140 degrees. Close to this scale, a vernier, *v*, is made to slide, so that the divisions of the scale are susceptible of subdivision into tenths, and the whole height of the tubes into about 2200 parts, or degrees.

On the left of the tube there is another strip of brass, with another set of numbers, so situated as to comprise two degrees of the scale, above mentioned, in one. Agreeably to this enumeration, the height of the tubes is, by the aid of a corresponding graduation on the vernier, divided into 1100 parts, or degrees.



A small strip of sheet tin, *k*, is let into a kerf in the wood, supporting the tubes, in order to indicate the commencement of the scale, and the depth to which the orifices of the tubes must extend. At distances from this, of 1000 parts and 2000 parts, (commensurate with those of the scale,) there are two other indices, T T, to the right hand tube. Let a small vessel, containing water, be made to receive the lower end of the tube, by the side of which the scale is situated, and a similar vessel of any other fluid, whose gravity is sought, be made to receive the lower end of the other tube, so that the end of the one tube may be covered by the liquid in question, and the end of the other tube, by the water.

The bag being compressed, a great part of the contained air is expelled through the tubes, and rises through the liquids in the tumblers. When the bag is allowed to resume its shape, the consequent rarefaction allows the liquids to rise into the tubes, in obedience to the greater pressure of the atmosphere without. If the liquid to be assayed be heavier than water, as, for instance, let it be concentrated sulphuric acid, it should be raised a

little above the first index, at the distance of 1000 degrees from the common level of the orifices of the tubes. The vessels holding the liquids being then removed, so that the result may be uninfluenced by any inequality in the height of the liquids, the column of acid must be lowered, until its upper surface coincide exactly with the index of one thousand. Opposite the upper surface of the column of water the two first numbers of specific gravity of the acid will then be found; and, by duly adjusting and inspecting the vernier, the third figure will be ascertained. The liquids should be at the temperature of sixty.

If the liquid under examination be lighter than water, as in the case of pure alcohol, it must be raised to the upper index. The column of water, measured by the scale of 1000, will then be found at 800 nearly; which shows that 1000 parts of alcohol are, in weight, equivalent to 800 parts of water—or, in other words, 800 is ascertained to be the specific gravity of the alcohol.

The sliding rod and tube at R, between the cock and the glass tubes, facilitates the adjustment to the index, of the column of liquid in the right hand glass tube. When the rod is pushed in as far as possible, it causes a small leak, by which the air enters, and the columns of the liquids, previously raised too high, by the bag, may be allowed to fall till the liquid, which is to be assayed, is near the index. Then, by pushing the rod in, they may be gradually lowered, and adjusted to the proper height with great accuracy.

A rod of this kind, graduated, might answer the purpose of a vernier.

The bag of caoutchouc may be advantageously furnished with two valves, one opening from the tubes into the bag, the other from the bag into the air.

But, upon the whole, I find a syringe preferable; the adjusting rod being included in the rod of the piston, which is perforated for its reception, and furnished with a stuffing box, to render it air tight.

The plummet P, and the screws at L, enable the operator to detect and rectify any deviation in the instrument from perpendicularity.

We cheerfully insert the above, and apologize to the Doctor for our inadvertence in overlooking his *litrameter*, which was certainly familiarly known to us; in fact, attaching no particular importance to the matter, we referred to the piece of apparatus, by Leyebours, as being the one which first came to mind, our object being merely to show that the thing had been long and well known. The exposition of Dr. Hare strengthens this our position.

Since, however, the subject has attracted some attention, (for we see by the English journals that Sir James Murray also sets up a claim to the invention,) we insert the annexed extract from the Physique Experimentale of Von Mussenbroek, published at Paris in 1769, which is as far back towards "the ancient Egyptians" as we have traced the apparatus:— COM. PUB.

Extract from Physique Experimentale par M. Von Mussenbroek, traduit par M. Sigaud de la Fond, Paris; Bauche, 1769: 4to. 3 vols.; tom. ii, p. 233, § 1395.

"Others have used for this purpose (the determination of the specific

gravity of different liquids,) a recurved tube of glass, A C D E B, Plate II, fig. 2, (Plate xxxii, fig. 2,) to the upper part of which is adapted a transverse tube, D K, the mouth of which, K, is adapted to the air-pump. Then, having plunged the two extremities, A and B, of the bent tube, into the vessels which contained the different liquids, they worked the piston of the pump, and thus partially exhausted the air contained in the branches; the external air then becoming preponderant, raised the liquids in the two branches; that contained in the vessel A, being raised to the height A C, and that of the vessel B to B E. They reasoned thus, as the pressure of the atmosphere is felt equally upon the liquid contained in the vessel A, and upon that in B, the two columns of liquids raised in the two branches weigh equally, and, consequently, the relative gravity of the liquid in A, is to that in B, as the height B E, is to the height A C. This way of determining the specific gravity of liquids is very ingeniously imagined, but is not more accurate than the preceding, for the difference of the attractions of the tubes for the different liquids which rise in them, (whence follow necessarily different degrees of concavity, or convexity, of the surfaces of the liquids,) is an obstacle which prevents us from judging accurately of the two heights of the liquids. For this reason this method has been rejected. Fig. 3, Plate II, (fig. 14, of plate xxix,) represents a machine which has been used for determining the specific gravity of force of different liquids; but this method is exposed to the same inconveniences."

Extracts from the Report of Capt. G. W. HUGHES, *of the Topographical Engineers, to the Secretary of War, relative to the working of Copper Ore.*

In the immediate neighborhood of Carglaze are the Cressoda porcelain clay works. Water is here also essential as a mechanical and purifying agent. It is brought to run over banks of disintegrated granite into a pool, artificially excavated, from which the coarser materials, such as quartz and mica, are removed in cars drawn up inclined planes by horse power, leaving in the pool a creamy looking substance, which is the crude, or impure, kaolin. This is pumped up, and conveyed to a reservoir where the heavy and insoluble matter, (called *mica* by the workmen, which is probably the predominating material, as the coarser and heavier quartzose particles have been already separated,) is deposited by subsidence. After an interval of some hours, the upper, or fluid, stratum is drawn off into lower vats, when it is left to slowly deposit the porcelain clay; and when the water has become nearly colorless it is drawn off, and the clay, left in a semi-fluid state, (of the consistency of Devonshire cream,) is pumped into a reservoir, where it is left to consolidate, and partially to dry, after having been separated by a kind of spade into cubes of about 6 inches; from whence it is removed, when sufficiently coherent, to platforms, where it is thoroughly dried in the sun. The wet season (1841) had been very injurious to these works, and the cubes were

much abraded by the rains. To protect them from the moisture, they are covered with straw, which adheres to the clay; the blocks must, therefore, be carefully scraped before they are fit for market.

Kaolin is very abundant in the vicinity of St. Austell, and in Dartmoor, Devonshire, and may be traced, in all cases, to a common origin, viz., to the natural decomposition of a talcose granite, similar to the French protegene. It makes a very good porcelain, (manufactured in Wales, and in Gloucestershire,) but, of course, very inferior to the celebrated *Sèvres*,* and even to the *Dresden*, china.

The coarser kinds of kaolin were employed by the Romans, in Britain, for various economical purposes, especially for reservoirs and water pipes, some of which have been recently discovered in a perfect state of preservation. It was suggested by the learned Professor, in the course of his remarks, that this material might be substituted for lead and iron gas, and water, pipes, at a comparative trifling cost. I can certainly see no reason why it may not be used to much advantage for the sub-drainage of lands, and for water pipes, where they are not likely to be subjected to any very great hydrostatical pressure.†

The great mineral district of the west of England, is that composed of the parishes of Gwennap, Redruth, and Cambourne; and, looking to extent of workings, amount and constancy of produce, regularity of system, and beauty of arrangements, the "Consolidated mines," or "Consols," as they are commonly called, may be regarded as the most important copper mines of that district, and perhaps of the world.‡

The Consolidated mines consist of several detached mines which were formerly worked, but not successfully, by independent companies of adventurers. Previous to the year 1818, they had all been abandoned, and became filled with water. In 1819, operations were resumed, by the union of six different mines; and the "Consols," as the union was called, consisted of Cusvea, Wheal Fortune, Wheal Lovelace, East Wheal Virgin, and West Wheal Virgin. In 1824, this association was still further enlarged by the addition of the "United mines," consisting of two mines called Ale and Cakes and Poldory, both of which had been formerly extensively and profitably worked by separate companies.

The Consolidated "selt,"‖ including the eight mines before men-

* The kaolin used at Sèvres, is procured from the quarries of Limoges, and is mixed with sand, sub-carbonate of soda, and nitrate of potash, (in proportions depending on the character of the materials;) to which is added pure alumine, when in a state of fusion. It requires an intense heat of wood fire to harden it. This substance is called *biscuit* before it is enamelled, and, when finished, is designated as *porcelain dure*, to distinguish it from the old fabric, formed from a mixture of glass and earths, called *porcelain tendre*. Many exquisitely beautiful models of celebrated statues, in biscuit, may be seen all over the continent, and more especially in Paris.

† It is estimated that about 37,000 tons of mineral matter are shipped annually from Devon and Cornwall, to the potteries. *China clays* sell at the works for £1 12s. 6d. per ton, and the *China stone* for 16s. per ton.

‡ For a more detailed and satisfactory account of these mines, see "Descriptive Notice of the Consolidated and United Mines," Mining Review and Journal, July, 1835; and Burr's "Elements of Practical Geology."

‖ The ground included within the boundaries of a mine is called, provincially, a selt.

tioned, covers an area of about two square miles, and is surrounded on all sides by extensive and productive mines of either copper, or tin. The direction, or strike, of the main lodes of the Consols, (like those already mentioned,) is nearly due east and west, while the contre-lodes run north-east and south-west. Of the main lodes there are eight, or ten, averaging about five feet in width, but occasionally swelling out to nine feet. The cross, or contre-lodes, are about eighteen inches wide.

The ground included within the limits of the Consolidated and united selts, is generally barren in an agricultural point of view, but Mr. Burr says, "some idea, however, may be formed of the mineral wealth of this tract, when it is stated that within the last sixty, or eighty, years, it has yielded metallic produce to the amount probably of five, or six, millions of pounds sterling;* to which may be added, up to this time, a million and a half more.

These works employ constantly over three thousand persons. In 1830 the entire of the capital which had been invested in these mining operations had been repaid, and, from that time, the produce has gradually increased. The last returns I have seen, gave, as the value of the ores sold, the large sum of £145,717; the expenses for the same period were £102,000, leaving a clear profit of £43,717. The Treseveon mine, although yielding a much less amount of ore, is even still more profitable, owing to its being very dry, and requiring comparatively little machinery to raise the water from it. It returns to the adventurers about £ 50,000 per annum clear profit.

The average quantity of fine copper produced annually by the Consols, is about 1800 tons, or nearly one-tenth of all the copper furnished by Great Britain. The quantity of prepared ores, yielding rather more than nine per cent., is about 17,000 tons; to obtain which nearly 80,000 tons of trash are raised to the surface. A small quantity of tin ore is also raised.

The Redruth railroad passes through the whole extent of these mines, and affords a cheap and convenient means for the transportation of ores to Restrongent creek, a tidal navigable stream, about four miles from the mines, from whence they are shipped to Swansea, in Wales; from the main, line branches are carried to the principal dressing floors and mine buildings, so that the ores from the mines, and the coal from Swansea, require no rehandling after they have been placed in the cars.

The "Great adit," already noticed in another part of this report, passes a short distance to the north of these mines, and serves as a general recipient for the waters pumped from the different lodes, and discharged through the branch adits.

According to Mr. Burr, these mines are about 1800 feet deep; the extent of horizontal under ground work is not less than 63 miles, while the aggregate depth of pit work, in 1835, was over 25 miles; these distances have probably been extended (to the present time) to at least 30 miles of vertical pit work. The same authority states that

* 1835. The United Mines have, within a few years, been detached, and are, at present, worked by a separate company.

the cost of working for discovery and exploration alone, for the twenty years preceding the year 1835, was, in round numbers, £300,000. At that time the machinery employed consisted of eight large steam engines, used for pumping, varying from 65 to 90 inch cylinders, and one of 30 inches, besides 8 steam engines of 20 inch cylinders, used for drawing ore and trash out of the mines. There was also a water wheel of 48 feet diameter, for pumping, one of 40 feet for driving machinery, and five smaller wheels (all of them being overshot,) for stamping and grinding ore, besides several *horse whims,* chiefly employed at the United mines. That gentleman estimated the engine power expended to be equivalent to 5000 horses; and adds, "that if it were exerted to its full extent, it would probably be equal to double that number."

When I visited the Consols, in 1841, the machinery had been increased by the erection of two large steam engines, and the enlargement of an old engine from a 70 to an 85 inch cylinder, and of another from an 85 to a 90 inch cylinder. Two other engines of 85 and 90 inches, respectively, were ready for use. I was kindly furnished at the mine with the annexed tabular statement, (marked D) to which I beg leave to refer for a minute account of all the details of the powerful pumping machinery employed at these mines.

The enormous amount of machinery, and consequent expenditure of money, connected with the working of the Consolidated and United mines, is owing, in a great measure, to their close proximity to the sea, and to the immense depth of the shafts below its surface, (about 1500 feet) which, of course, causes a great influx of water from that source.

*Copper, Copper Ores, and their Treatment.**

Copper is one of the most useful and the most anciently known of the metals. It has a peculiar red color, and a disagreeable taste and smell. Its density, which is 8.788 when first reduced and refined, is increased by cold hammering, and becomes equal to 8.878. It fuses at about 27° of Wedgewood's pyrometer, and crystalizes, by slow cooling, in the form of quadrangular pyramids. Copper is very malleable, whether cold, or hot, and of great tenacity when pure; when cast in the open air it emits vapors, which are condensed upon the surrounding bodies, and appear to be a mixture of the protoxide of copper and of metallic copper. In humid air it undergoes a change, and becomes covered with a green coating of hydrate and carbonate of copper.

Nitric acid, whether cold, or hot, acts upon it rapidly; sulphuric acid acts upon it only when concentrated, and at an elevated temperature.

Copper combines with oxygen in three different proportions, and with sulphur in two.

* In the preparation of this portion of the report, I have, besides my own MS. notes, consulted the following works, viz., Grande Dictionare de Technologie, Ure's Dictionary of Arts, Mining Review, De la Beche's Economic Geology, First Bulletin of the National Institute, and Cleaveland and Phillips' Mineralogy, to which reference is made for more minute information.

According to Mr. Berthier, some thousandths of potassium render copper very soft and malleable. This alloy is easily formed by melting refined copper with a little cream of tartar, or with carbon, which has absorbed a solution of carbonate of potash.

It occurs in nature under a great variety of forms:—

1st. In a native state, in regular crystals, *cubes*, *octahedrons*, or *dodecahedrons*, in grains, in stalactites, in branches, or filaments, and generally in amorphous masses. The largest mass ever known of native copper, is the "Ontonagon Rock," weighing 3,704 pounds, from the south shore of Lake Michigan, now in the Musuem of the National Institute at Washington. In the "Consols" and "United mines," Cornwall, it is found generally in the cross courses, enveloping sulphuret of copper, and sometimes in the fissures of the killas, near the lodes.

2nd. Sulphuret of copper, (hany) or vitreous copper, (brochant) of which a great many varieties are known. It is very rich, yielding, when pure, about 80 per cent. of copper. It is often crystalized, and presents a shining lead color, and is sometimes iridescent; but its color is usually dark. Beautiful crystals of this ore are found in St. Just and Cambrea mines, Cornwall.

3rd. Copper pyrites, pyritous copper, or bi-sulphuret* of copper, strongly resembles sulphuret of iron; but the latter is less pale in color, is harder, and gives fire more readily with steel. It often presents the most rich and beautiful rainbow colors. When pure, it yields 30 copper, 37 sulphur, 33 iron. The best Swedish pyrites give 63 copper, 25 sulphur, 12 iron. This is by far the most abundant and common ore of copper. It is found chiefly in primitive and transition districts, but sometimes in secondary rocks, and is associated with the other ores of copper, spary, and magnetic iron, oxides of tin and arsenic, sulphurets of zinc, lead, and iron, fluate of lime, and quartz. It is called yellow ore by the miners, and is the principal ore worked in Sweden, Great Britain, and Ireland, Cuba, Chili, at Cressy, in France, and also at Mansfield, in Germany, where it is found in a slaty bed about 6 inches thick, which is called *cupreous schist*, which yields only about 1½ per cent. of copper, is occasionally argentiferous, and has been profitably worked for centuries. It contains many fossil fish converted into copper pyrites. Here is also found fossil monitors.

4th. Gray copper. Its composition is variable, but consists essentially of copper, iron, antimony, arsenic, and sulphur. In the gray copper of Guadalcand, in Spain, Vauquelin found 10 per cent. of platina. According to Ure, it contains silver, and is often profitably worked on that account. It occurs in primitive mountains, and is often mixed with red silver, copper pyrites, and crystalized quartz. Tennantite is composed of copper, iron, sulphur, arsenic, and silex.

5th. Oxide of copper. The red, or protoxide, is of a deep red color; it occurs compact and crystalized, and is sometimes in filaments; it dissolves in muriatic acid without effervescence, but it effervesces with nitric acid. It is very rich, but not abundant, yielding, according to Chenevix, 88.5 copper, 11.5 oxygen. Cleaveland says it is never

* Allan, De la Beche. Beautiful specimens of azure copper are found at Cressy.

found in large masses. I have, however, seen, in the Museum of Economic Geology, London, a very large rock of it, yielding over 80 per cent. of metal.

6th. The black oxide is of a velvet black color, inclining sometimes to brown, or blue; it acquires a metallic lustre on being rubbed. It is a true peroxide, and consists of copper 80, oxygen 20. It is found in Cornwall in the form of a black powder, and is there called podre.

7th. Hydrosilicate of copper. Chrysocolla, (Phillips.)

8th. Dioptase, a rare and beautiful emerald malachite, consisting of oxide of copper, carbonate of lime, silica, and water.

9th. Carbonate of copper, blue and green, sometimes found in beautiful crystals, and is often valuable as a gem. It has been sometimes manufactured into large and valuable vases and tables, which have formed the objects of imperial presents.* The green and blue carbonates are found in beautiful crystals at Chessy.

10th. Sulphate of copper.

11th. Phosphate of copper.

12th. Muriate of copper.

13th. Arseniate of copper.

The Treatment of Copper Ores.

The principal copper ores are arsenical, or sulphurous, or a mixture of both. The reduction of copper requires numerous operations, on account of the great affinity which exists between this metal and sulphur, and arsenic. These operations, often multiplied, are simple in themselves, and are reduced to calcinings, roastings, and meltings, which are repeated until its purification is sufficiently advanced. Copper obtained from these ores is never absolutely pure. It contains arsenic, antimony, and sometimes tin in small quantities, and cannot be employed in the alloys of silver and gold.†

The proportion of metallic copper contained in ores, is sometimes so small, that it can be profitably reduced only in places where, as in Sweden, fuel is cheap.

The treatment of different ores should vary with their qualities, but the processes are essentially the same; but, as the limits of this paper will not permit me to specify all the modifications in detail, I shall restrict myself to designating the operations to which pyritous ores, containing but a small proportion of sulphur, and gray, or argentiferous, copper, are subjected in different countries.

The treatment of the first two varieties begins with a sorting by hand, which consists in putting a side all the fragments as large as hens' eggs, and from amongst them to separate and reject the stony pieces. Those which remain are broken according to their size, and all reduced to fragments not larger than walnuts. Another selection, or picking over, is then made, for the purpose of sorting them according to their richness, and rejecting those which are altogether stony.

* A large and beautiful malachite table may be seen in Hamilton Palace, a very large and costly vase at Windsor Castle, and another at the Palace of the King of Holland, in Brussels, all presents from the Emperor Alexander.

† Copper used for this purpose is obtained by cementation, a process to be described hereafter.

The others form three qualities, viz., 1st, fragments of pure ore; 2nd, fragments slightly intermixed with foreign matter; and 3rd, fragments of the poorest kind. This sorting is more, or less, rigorous, according to the expense of the subsequent treatment, consisting of the price of fuel, manual labor, transportation, &c.

No. 1, is broken on a cast-iron bed, by means of a batte, or flat beater, formed of a piece of iron six inches square and one inch thick, adapted to a wooden handle, into fragments not larger than filberts. The selection and breaking are usually done by women and children. When this is completed, the ore is ready for calcination. No. 1, is called *prills* in Cornwall. No. 2, the dredge ore, as it is termed, is spalled by the batte, and then sent to the workshops to be riddled (sifted) and washed. No. 3, (the *halvans*, or leavings,) is sent to the crushing mills.

When the ores are not sufficiently pure to be separated by selection, the remaining operations are based upon the relative specific gravities of the materials subjected to dressing, and they are ground to various degrees of fineness, so as to render the ores separable from the foreign matter, by the agency of running water. Steam stamping mills are usually employed for this purpose, when the ores are finely disseminated through the vein stone, or when the matter of the gangue is very hard.

In Cornwall, the ores at many establishments are broken by means of crushing mills, instead of being broken by battes. As the crushed ore falls from the crushing rollers, or cylinders, it is received in an inclined cylindrical sieve, which, by turning on its axis, permits the larger sized ore to slide down to the bottom, while the smaller passes through its meshes. The pieces which do not pass through the sieve are returned to the crushers.

The small pieces of ore separated in the first selection, and from which all fragments larger than hens' eggs were sorted, are then sifted on an iron wire riddle; the intervals between the wires are about five lines. A workman, by repeated shaking of the riddle, filled with ore, and immersed in running water, separates it into three parts: 1st, the fine particles, which are carried off by the current, and deposited in a distant portion of the pool:* 2nd, the fragments, which are deposited under the riddle; 3rd, the largest pieces which remain on the riddle. The last are spread out on a table, and assorted by hand. The fragments not rejected as too poor are then broken, and re-submitted to the above named operations.

The ore deposited under the riddle is re-sifted, and the No. 2, broken when the separation into three classes was made, is added. The meshes of the sieve are from twenty to thirty to the square inch. The workman who manages it shakes it by two handles, with a compound motion, both round and vertically, immersed in a shallow pool of water, above which it is never lifted. The finest particles pass through the sieve; those that remain above it are divided, by the difference of their specific gravities, into three parts. The lightest, which is above, contains so little metal that it is thrown away; the middle

* This pool, or basin, is called a "buddle," and the process is termed "buddling."

portion is sent to the stamping mills, and the lower part, the richest of all, accumulated during two, or three, siftings, needs only to be placed on a slightly inclined plane, and to be stirred with a rake while it is washed by a small stream of water flowing gently over it. This operation, which is called "jigging," is, at most of the well regulated Cornish mines, performed by machinery. A rectangular sieve is suspended in a box of the same shape, filled with water, and a vibratory motion is communicated to the sieve by a working rod, connected either with a water wheel, or a steam engine, as may be most convenient. The old method is still followed on the continent, and may still be seen in England at the smaller mines.

The fine ore passed through the sieve is separated into two parts by stirring in water. The richest, fallen to the bottom, requires but one washing. Finally, the different classifications of ores sent to the crushing and stamping mills, and separated from the non-metaliferous substances with which they were mixed, by stirrings and washings on inclined planes, constitute the *prepared ores*, ready for sale and reduction; while the stony parts, which always retain some ore, are thrown away.

It occasionally happens that tin ores are mixed with the copper ores, and, in consequence of their great specific gravity, are accumulated at the head of the buddle. When this is the case, they are roasted, and treated like tin ores; and the copper pyrites, being converted into sulphates in the calcining furnaces, are dissolved, and separated by cementation.

As all the copper ores mined in Cornwall and Devon are taken to Swansea for reduction, owing to the want of fuel in the mining districts, they are sold at the mines to the agents of the smelters, who pay for the transportation to the furnaces. Sales take place, weekly, at Truro, Redruth, or Pool, by what is called "ticketing." It is usual when the results of the last sale are published, says M. De la Beche, to announce those that will take place at the two next ticketing days, distinguishing the mines, and the number of tons of ore (of 21 cwt.,) which each intends to sell. The system of selling ores, by ticketing, has prevailed in Cornwall for the last one hundred and twelve years; and is thus described by Borlase, as practiced in his time: "A quantity being sorted, cleaned, and divided into heaps, according to the quality of the ores, the agents of the copper companies of Wales and Bristol, (who reside at Truro and Redruth,) upon notice given, attend to sample the ore, and each sampler having taken from each pile as much as is sufficient for assaying and ascertaining the value of that pile, a day is appointed, by joint consent of seller and buyer, at such distances as may give the sampler time to repeat and verify his assays for the sale of the copper. On the fixed days, each of the samplers attends, and produces a *ticket*, or written paper, sealed up, in which is expressed the price which each sampler will give for the ore; he who bids most has the ore." This plan is essentially the same as that followed at the present time.

M. De la Beche observes, "that the mode of assaying copper ores in Cornwall, is usually conducted in a somewhat rough manner, and

accurate results can scarcely be expected from it. Indeed, chemistry has, as yet, made little progress amongst the assayers of Cornwall." The assays are conducted by the dry mode, and are somewhat analogous to the process of reduction on a large scale, and are nearly the same as those described by Price, sixty years ago. The humid assay is the most exact, but it requires more skill and time. Ure gives several methods, (dry and wet.) The following, for a dry assay, is, perhaps, as good as any other: "A portion of the mixture, (prepared ore) tried by the blow-pipe, will show, by the garlic, or sulphurous, smell of its fumes, whether arsenic, sulphur, or both, be the mineralizers. In the latter case, which often occurs, 100 grains, or 1000 grains, of the ore are to be mixed with the one-half its weight of sawdust, then imbued with oil, and heated moderately in a crucible, till all the arsenical fumes be dissipated. The residuum, being cooled and triturated, is to be exposed in a shallow earthern cup to a slow roasting heat, till the sulphur and charcoal be burned away; what remains being ground and mixed with half its weight of calcined borax; one-twelfth its weight of lamp-black, next, made into dough, with a few drops of oil, is to be pressed down into a crucible, which is to be covered with a luted lid, and to be subjected, in a powerful air furnace, first to a dull red heat, then to vivid ignition for twenty minutes. On cooling and breaking the crucible, a button of metallic copper will be obtained. Its color and malleability indicate pretty well the quality, as does its weight the relative value, of the ore. It should be cupelled with lead, to ascertain if it contain silver, or gold.

If the blow-pipe trial showed no arsenic, the first calcination may be omitted, and if neither sulphur nor arsenic, a portion of the ground ore should be dried, and treated directly with borax, lamp-black, and oil. It is very common to make a dry assay of copper ores, by one roasting, and one fusion, along with three parts of black flux; from the weight of the metallic button the richness of the ore is inferred.

Ores of the oxide of copper are easily analyzed by solution in nitric acid, the addition of ammonia to separate the other metals, and precipitation by potash. The native carbonate is analyzed by calcining 100 grains, when the loss of weight will show the amount of water and carbonic acid; the latter may be found by expelling it from another 100 grains, by digestion in a grain weight of sulphuric acid. The copper is finally obtained in a metallic state, by plunging bars of zinc into the solution of the sulphate."

Berthier, (Traité des Essais par la Voie Séche, tom. ii, p. 474,) describing assays of the sulphurets of copper, mixed with iron, (such as the workable ores usually are,) and after noticing the roasting, in which it is necessary to stir the particles of ore continually, so that all should come in contact with the air, says, "that when the roasting is somewhat advanced, the heat should, from time to time, be increased to a bright red, in order to make the sulphurets and sulphates act upon each other, and produce reciprocal decomposition. When the sulphurous acid ceases to be disengaged, a white heat should, for some minutes, be produced, to decompose the last trace of sulphate. When

the roasting has been conducted with care, the assay, melted with three, or four, times its weight of black flux, will give nearly all the copper which it contains, and the iron will remain disseminated through the slag, partly in a metallic state, and partly in a state of oxide. If the roasting has been imperfect, the slag will be sulphurous, and retain copper in combination. With poor copper ores, the slag also retains a good deal of copper, but this loss may be greatly decreased by adding about one part of borax to the black flux, in order to render the scoriæ more liquid; but it is preferable, in such cases, to assay by the humid way;" which, indeed, Berthier strongly recommends for ores of this class, when they are mixed with much iron.

The first operation to which prepared cupreous pyrites are subjected, as a preliminary to reduction, is that of calcination, with the view of depriving them of a portion of their sulphur and arsenic. For this purpose the ore is piled up in furnaces, or in the open air. In the first case, it is placed in alternate layers, with the fuel in furnaces, resembling lime-kilns, or formed simply of a square case of masonry. This is the Bohemian method. The roasting continues for three weeks; the fire is kindled below; by degrees the sulphur is disengaged, and lost in the air. A portion of the sulphur, in burning, serves gradually to heat the whole mass, and the combustion extends slowly to the upper parts.

In the second case—that of calcining, in heaps, in the open air—the ore is piled up in great masses in the form of truncated quadrangular pyramids, with the fuel at the bottom. In the centre of the mound is a wooden chimney, with charcoal at the bottom; an opening is left in the middle of each side, through which a current of air is admitted under the wooden chimney, by which means ignition is produced, when fire is thrown down the chimney, and combustion supported. This pyramid is covered with mortar, sods, &c., and hemispherical cavities are dug on the upper surface, for the purpose of receiving the sulphur, which, during the roasting of ore, arrives liquefied at the surface. This method of roasting, which is practicable only when the ore is very sulphurous, is employed at Chessy, near Lyons, in France, and at Goslar, in the Lower Hartz. It lasts about six months, at the end of which period the sulphur ceases to escape. The mass is then left to cool, and when this is accomplished the ore is fit for smelting.

In the calcining operations, the volatile substances are mostly disengaged in a gaseous form, while the metals, owing to their strong affinity for oxygen, become oxidized. In melting, the earthy matters unite with these oxides, and form slags, which float on the surface of the molten metal.

When the pyritous copper is sufficiently calcined,* whether in the open air, or in kilns, it is carried to a peculiarly shaped furnace, called, in France, "fourneau à manche," or elbow furnace, much resembling

* When properly calcined, the ore scarcely changes weight, inasmuch as it gains as much oxygen as it loses of volatile matter, and is reduced to the state of a *black* powder, owing to the oxidation of the iron.

the Scotch furnace used in Cumberland for smelting lead; this furnace is charged with a mixture of charcoal and prepared ore, earthy matter being sometimes added as a flux, to render the gangue fusible. The scoriæ of previous meltings are also added; they assist the fusion, and always furnish a little copper which they had retained. In proportion as the material melts, it runs to the bottom of the furnace, which is formed something like a pocket, or large crucible. This receptacle is lined with a mortar made of burnt and raw clay and charcoal; when it is filled with liquefied substances, the workmen rake the surface with an iron rable, and they continue to remove the scoriæ till the pocket is filled with rich metallic matter. The last scoriæ removed contain particles of metal, and are re-melted in the succeeding operations. The pocket is now emptied into a vat, or bath, lower down. From this bath the scoriæ, floating on the top, are removed, to be again melted with ore. The surface of the melted metal is then sprinkled with water, and a layer, hardened by cooling, is removed. The surface is again sprinkled, and another layer detached, and so on until the whole is exhausted. All these strata, which are called *mattes*, are taken to the roasting furnaces.

When these mattes have been sufficiently roasted, (the object of which is to still further oxidize the iron,) they are removed to a reverberatory smelting furnace; the results of this fusion are scoriæ, new mattes, less impure than the preceding, and *black copper*, (oxide and sulphuret of copper,) which is laid aside to be refined.

The second mattes are taken back to the roasting furnace, there melted anew, to be again roasted. In these operations, they again give scoriæ, mattes more pure, and black copper, which are removed to the refinery. In continuing this process, all the ore is successively converted into copper and scoriæ; and, after the latter have been as much as possible exhausted, as shown above, they are thrown away. Those that are rejected seldom contain more than half of one per cent. of metal, as is shown by comparing the amount of reduction with the selling assay. The foregoing method is followed at Chessy, and may be called the continental system.*

Before proceeding to describe the process of refining, I will explain another mode of treatment for prepared mineral after the first calcination.

When the raw ores do not contain a sufficient proportion of iron pyrites, to furnish enough sulphur to sustain spontaneous combustion for a sufficient length of time, it becomes necessary to have recourse to other means, and to operate as they do at Swansea, where the whole treatment of the ore is in reverberatory furnaces. The calcinations and the fusions succeed each other in the following order, viz., first, calcination of the ore; second, melting of the calcined ore;

* In the "Annales du Comptoir des Mines de Fer," in Sweden, for 1834, it is said, "that hitherto the Fahlun copper ores have been roasted in rectangular spaces, but some recent experiments have satisfactorily shown that reverberatory furnaces are the best. The ore must be reduced to the state of a coarse powder; in which condition it requires only eighty hours for completing the process. H. C. Strom, State officer of mines in Norway, thinks differently, and gives the decided preference to the continental method, as will be shown in another part of this paper.

third, calcination of the first matte; fourth, melting of the calcined matte; fifth, calcination of the second matte; sixth, melting the second calcined matte; seventh, roasting the black copper, (in many establishments they repeat the roasting four times in succession, in which case one calcination, and one melting are omitted;) eighth, refining the copper. Finally, besides these operations, two others are generally performed, the re-melting of the portion of the scoriæ of the second operation, which retains metallic granules, and the melting of the scoriæ of the fourth operation for the purpose of concentrating the particles of copper in the scoriæ.

The ore is more carefully prepared than on the continent. It is reduced into pieces about the size of filberts, and then spread on the bottom of a reverberatory furnace to calcine. The furnace is heated gradually, taking care not to push the temperature to the point of melting, or agglutinating, the pieces; and they stir the ore very frequently, in order to renew the surface, and to multiply points of contact with the flame. This calcination generally continues for twelve hours, at the end of which time a portion of the sulphur and arsenic is disengaged. The ore absorbs oxygen, is reduced to a black powder, and still contains much sulphur and arsenic. When the calcination is finished, the materials are *dumped* into a vault below the furnace. In this state the ore is ready for a first fusion, which operation is performed in a common reverberatory furnace. Scoriæ and different fluxes are added, according to the nature of the ore. After a heating of four, or five, hours the fusion is completed. During the melting the mass is repeatedly stirred with a rake, to aid in the disengagement of the slag, which is removed by a rake as often as it rises to the surface. They add a fresh charge of calcined ore, again remove the scoriæ, and add a third charge; this time the scoriæ are carefully skimmed off; the stopple is removed, (or the luting pierced,) and the molten metal runs into a pool of water; in falling into this liquid, it hardens in separate granules, which remain red, at the bottom of the basin. The granules thus obtained, present, in their fracture, a steel grey color, and a metallic lustre. By this process the copper is concentrated by the separation of much foreign matter with which it was combined; but the matte, in this state, is far from having attained the necessary degree of purity. It contains but 33 per cent. of copper, much sulphur and arsenic, and some iron; in consequence of which it must be several times calcined and melted in a reverberatory furnace, according to the composition of the ore. These calcinations and fusions are ordinarily repeated eight, or ten times, and it is granulated, in order that it may be more easily calcined. At each melting the slags are skimmed off, but they are removed, to be melted with a first fusion, because they always retain a small quantity of metal, but little intermixed with foreign matter.

If the second fusion be granulated, it is called *fine* copper, but if run into pigs it is termed *blue* copper; it contains about 60 per cent. of copper.

The greater, or less, degree of impurity renders necessary successive meltings and calcinations, more, or less, numerous. These operations

must be multiplied until the grains are sufficiently refined; which is ascertained by the color, by rolling, cutting in two, and by bending till they break. The color of the fracture indicates the suitable degree of purity. The next process is that of roasting, as we shall see below.

When the grains contain enough silver to justify its extraction, they are melted with three times their weight of lead.

Commonly, when the ore contains silver, which is often the case with grey copper, it is imperfectly melted before calcination, with the object of separating a great part of the gangue in the state of scoriæ. This operation produces a matte, consisting of sulphur, copper, iron, and silver. This matte is then calcined, and melted with plombiferous materials, by which fusion three products are obtained, 1st, a matte, which must be again calcined; 2nd, argentiferous, plombiferous copper, which is liquated; 3rd, argentiferous cupreous lead, which is cupelled. Liquation and cupellation produce impure copper and silver.

In order to liquate the copper, or sweat out the silver, it is run into flat pigs, which are subjected to liquation at a temperature a little above that of red heat for two, or three, days, in the same manner that bronze is refined. These pigs, which are called *liquation cakes*, are arranged horizontally on iron bars above a cast-iron trough. The lead is first melted; it falls from the pigs in small drops, carrying with it the silver; but all the lead does not escape.

This lead is afterwards converted into litharge, in order to extract from it the silver.

The cakes of copper are thus left all riddled, as it were, with holes, resulting from the empty spaces left by the melted lead; and having become much less fusible, they require a great augmentation of heat, in order to get rid of the remainder of the lead. The cakes of liquation, or what has remained of them, are then melted and granulated, calcined, and again melted, until the metal is sufficiently soft and malleable. It is then run into a mass. In this state it is fit for the refinery; but before being melted for refining it is broken into pieces. This is the process usually observed in treating the sulphuret of copper, or the grey copper ore.

To be Continued.

Extracts from an article on the Practice of the Calotype Process of Photography. By Geo. S. Cundell, Esq.

4. The Daguerréotype plate owes its sensibility to the iodide of silver, obtained by exposing the metal to the vapor of iodine. The same compound, iodide of silver, is the foundation of the calotype also; but it is obtained by a "humid" process, by the decomposition of nitrate of silver, upon the surface of paper, by means of a solution of the iodide of potassium. It has been found that paper so prepared, when treated with gallic acid, becomes exceedingly sensitive; and that upon the slightest exposure to daylight, under particular treat-

ment, it will become perfectly black and opaque. Hence its fitness and adaptation to receive the delicate, but feeble, impressions of the images formed in the camera obscura, which imprint upon it what has been called a "negative" picture, having the lights and shadows of nature reversed. This "negative," when fixed and rendered permanent, is used as a matrix, and, by a simple and well known process, a great number of impressions may be photographically printed from it, representing objects not only in true light and shadow, but true also in relation to right and left.

5. Before any thing good can be produced in calotype, the operator must be provided with a properly constructed camera obscura. The cameras met with in the shops are generally made after the French model, with nominally achromatic lenses, of the plano-convex figure, and of a short focus. Without presuming to disparage these, which, no doubt, will give a portion of well defined picture in the centre of the field, sufficient for a single portrait, I would venture to recommend, on the authority of Dr. Wollaston, a lens of the meniscus figure, having the radii of its curves in the proportion of two to one.

6. He has shown, in an essay on the particular subject, (in the Philosophical Transactions for 1812,) that the miniscus figure, *when properly "stopped,"** is peculiarly adapted to the camera obscura, from its property of producing a comparatively *flat* and focal field throughout the picture, when the picture is received upon a plane surface (§6.) Without undervaluing the advantage of corrected aberration, it may well be doubted whether you do not lose more than you gain by the plano-convex figure, even though achromatic, from the impossibility of bringing its picture, when of any extent, to a tolerable focus. Achromacy, is, no doubt, desirable, but in calotype, where the image is not to be magnified, it is, by no means indispensable, as any one may prove who fairly tries the experiment; and the expense of a really achromatic lens of an adequate aperture must put it in a great degree out of the question. Perhaps the best substitute for it would be a lens of *blue* glass, which would transmit nearly the whole of the chemical rays to a common focus. But of whatever figure the lens may be, and of whatever color, it will not be unimportant that the focus be considerably longer than that commonly used.

7. In order that a picture in perspective may be seen with truth and satisfaction, it is necessary that it be seen from a particular point of view, in which the eye has the same relation to the picture that it would have to the object represented. The picture must subtend at the eye the same angle as the object, and unless it do, it will always look more, or less, distorted and unnatural. The principle is well illustrated in the diorama, the illusion and the charm of which depend in no small degree upon the placing of the spectator at the proper height and distance; but the principle applies to all pictures in per-

* His improvement is a very striking one, and it seems odd, that the principal part of it, upon which the effect chiefly depends, his mode of stopping out, and admitting the light, is precisely the part which (so far as I am aware) has been entirely overlooked in practice, and in every popular treatise on the subject.

spective, and to camera pictures in particular, which are wonderfully improved when placed at the proper distance from the eye. Calotype pictures are not intended to be looked at, and are seldom viewed at a shorter distance than twelve inches; and in order that such a picture viewed at that distance, may be seen in *true* perspective, the lens of the camera must be of twelve inches focus. In portraiture the effect may be less obvious than in architecture, or in general subjects, but there can be no doubt that a portrait taken by a lens of six inches focus, viewed at the distance of twelve inches, would lose a great part of any truth, or likeness, it might really possess.

8. For these reasons the lens ought not perhaps to be less than 12 inches focus, and, if mounted in the manner shown in Plate II, fig. 4, it will be found to be generally convenient.

There is no novelty in this construction, unless perhaps in the introduction of the diaphragms A B, and C D, and in the elongation of the mouth-piece, both of which are useful in protecting the picture from all external light, except that which emanates from the objects to be copied; the rays from the direction *b*, being intercepted at B, and those from *d*, at D. The paper is placed between two plates of glass, introduced at the open end G H, and these are pressed together and secured in their place by means of a detached door having a revolving bar behind it, the extremities of which work in grooves in the sides of the outer case.*

9. By reference to the diagram, it will be seen that by means of the diaphragm, or "stop," E F, the rays from the barb of the arrow are excluded from the upper, and received only upon the lower, half of the lens, upon which they fall at a comparatively high and *equal* angle of incidence. They are thus less refracted than they would otherwise be, and their focus is not only sharpened but elongated. By this means the picture, instead of being formed in the usual curve, is formed much nearer to a straight line in the plane of the paper placed to receive it.

10. A lens of twelve inches focus ought to have an aperture of 2.4 inches. The diaphragm at E F, (in which the principal virtue of the instrument resides,) ought to be placed 1.5 inch in advance of the lens, and its opening ought not to exceed 1.2 inch. By using one of a smaller opening, a much finer image will be obtained, but at the sacrifice of light; at short distances, however, on account of the increasing divergency of the rays, only a small opening, admitting the mere centres of the pencils, can be used with advantage. The size of the plate glasses may be eight inches by six.

11. It must be observed of this camera, and of all others which are not achromatic, that there is a peculiar adjustment required of the focus, the not attending to which has been the cause of much failure and disappointment.* The instrument must be adjusted to what has been appropriately called the *chemical* focus, which differs materially from the optical, or visible, focus, as will be seen by the following table, in which the two are contrasted; the former being about one-

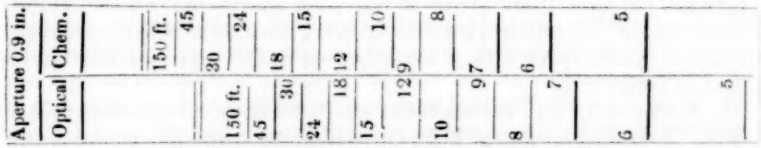
* The instrument, much improved, may be had of Mr. Dennis, No. 118 Bishopsgate street Within.

thirty-sixth part shorter than the latter for parallel rays, and for diverging rays in proportion.

Principal focus = 12 inches.*

Distance of object.	Visible focus.	Chemical focus.	Difference.
Feet.	Inches.	Inches.	Inch.
5	15.00	14.49	0.51
6	14.40	13.93	0.47
7	14.00	13.55	0.45
8	13.71	13.28	0.43
9	13.50	13.09	0.41
10	13.33	12.93	0.40
12	13.10	12.71	0.39
15	12.86	12.47	0.39
18	12.70	12.32	0.38
24	12.52	12.16	0.36
50	12.24	11.90	0.34
100	12.12	11.78	0.34

12. It will be found convenient to insert one, or more, strips of white wood in the sliding part of the camera, as shown in the drawing, and to graduate these with the foci produced by the different "stops" used at E F. This graduation is best done by first accurately determining the visible foci (by daylight) of two fiducial points near the extremities of the scale, by means of a test object, and a magnifier, and then setting off by measure the calculated differences; thus, for a twelve inch lens,



When the instrument is thus graduated, the focus may be set in an instant, with an accuracy which is quite unattainable by the unassisted eye, by merely measuring the distance of the object, if near, or by guessing at it, if out of reach.

13. To produce a calotype picture there are five distinct processes, all of which, except the third, (§25) must be performed by candle light; they are all very simple, but, at the same time, all of them require care and attention. The first, and not the least important, is

14. *The Iodizing of the Paper.*—Much depends upon the paper selected for the purpose; it must be of a compact and uniform texture, smooth and transparent, and of not less than medium thickness. The best I have met with is a fine satin post paper, made by "R. Turner, Chafford Mill." Having selected a half sheet without flaw,

* For lenses of a different focus, the graduation will be in proportion, *at proportionate distances;* thus, for a lens of six inches, the spaces will be one-half the above, at *half the distances.*

or water mark, and free from even the minutest black specks, the object is to spread over its surface a perfectly uniform coating of the iodide of silver, by the mutual decomposition of the two salts mentioned in §4. There is considerable latitude in the degree of dilution in which these salts may be used, and also in the manner and order of their application; but as the thickness and regularity of the coating depend upon the strength of the solution of nitrate of silver, and upon the manner in which it is applied, I think it ought, by all means, to be applied first, before the surface of the paper is disturbed; and I am inclined to believe, that if the solution be used of double the strength suggested by Mr. Talbot, the coating will be found more perfect and continuous, and will produce better pictures. I use, accordingly, a solution of the strength of thirty grains to the ounce of distilled water.

15. The paper may be pinned by its two upper corners to a clean dry board a little larger than itself, and, holding this nearly upright in the left hand, and commencing at the top, apply a wash of the nitrate of silver *thoroughly*, *evenly*, and *smoothly*, with a large soft brush, taking care that every part of the surface be thoroughly wetted, and that nothing remain unabsorbed in the nature of free, or running, solution. Let the paper now hang loose from the board into the air to dry, and by using several boards time will be saved.

16. The nitrate of silver spread upon the paper is now to be saturated with iodine, by bringing it in contact with a solution of the iodide of potassium; the iodine goes to the silver, and the nitric acid to the potash.

17. Take a solution of the iodide of potassium of the strength of 200 grains to a pint of water, to which it is an improvement, analogous to that of M. Claudet, in the Daguerréotype, to add fifty grains of common salt. He found that the chlorinated iodide of silver is infinitely more sensitive than the simple iodide, and by this addition of common salt, a similar, though a less remarkable, modification is obtained of the sensitive compound. Pour the solution into a shallow flat bottomed dish, sufficiently large to admit the paper, and let the bottom of the vessel be covered to the depth of an eighth of an inch. The prepared side of the paper having been previously marked, is to be brought in contact with the surface of the solution, and, as it is desirable to keep the other side clean and dry, it will be found convenient, before putting it in the iodine, to fold upwards a narrow margin along the two opposite edges. Holding by the upturned margin, the paper is to be gently drawn along the surface of the liquid until its lower face be thoroughly wetted on every part; it will become plastic, and in that state may be suffered to repose for a few moments in contact with the liquid; it ought not, however, to be exposed in the iodine dish for more than a minute altogether, as the new compound, just formed upon the paper, upon further exposure would gradually be re-dissolved. The paper is, therefore, to be removed, and, after dripping, it may be placed upon any clean surface with the wet side uppermost until about half dry, by which time the iodine solution will have thoroughly penetrated the paper, and have found out and saturated every particle of the silver, which it is quite

indispensable it should do, as the smallest portion of undecomposed nitrate of silver would become a black stain in a subsequent part of the process.

18. The paper is now covered with a coating of the iodide of silver, but it is also covered, and indeed saturated, with salt-petre, and with the iodide of potassium, both of which it is indispensable should be completely removed. To effect the removal of these salts, it is, by no means, sufficient "to dip the paper in water," neither is it a good plan to wash the paper with any considerable motion, as the iodide of silver, having but little adhesion to it, is apt to be washed off; but the margin of the paper being still upturned, and the unprepared side of it kept dry, it will be found that, by setting it afloat on a dish of clean water, and allowing it to remain for five, or ten, minutes, drawing it gently now and then along the surface to assist in removing the soluble salts, these will separate by their own gravity, and (the iodide of silver being insoluble in water,) nothing will remain upon the paper but a beautifully perfect coating of the kind required.

19. The paper is now to be dried, but while wet, do not on any account touch, or disturb, the prepared surface with "blotting-paper," or with any thing else. Let it merely be suspended in the air, and, in the absence of a better expedient, it may be pinned across a string by one of its corners. When dry it may be smoothed by pressure. It is now "iodized," and ready for use, and in this state it will keep for any length of time if protected from the light. The second process is that of exciting, or

20. *Preparing the Paper for the Camera.*—For this purpose are required the two solutions described by Mr. Talbot, namely, a saturated solution of crystalized gallic acid in cold distilled water, and a solution of the nitrate of silver of the strength of fifty grains to the ounce of distilled water, to which is added one-sixth part of its volume of glacial acetic acid. For many purposes these solutions are unnecessarily strong, and, unless skilfully handled, they are apt to stain, or embrown, the paper; where extreme sensitiveness, therefore, is not required, they may with advantage be diluted to half the strength, in which state they are more manageable, and nearly as effective. The gallic acid solution will not keep for more than a few days, and only a small quantity, therefore, should be prepared at a time. When these solutions are about to be applied to the iodized paper, they are to be mixed together, in equal volumes, by means of a graduated drachm tube. This mixture is called "the gallo-nitrate of silver." As it speedily changes, and will not keep for more than a few minutes, it must be used without delay, and it ought not to be prepared until the operator is quite ready to apply it.

21. The application of this "gallo-nitrate" to the paper is a matter of some nicety. I doubt if it be possible to apply it successfully with *brushes;* and it appears to me that one application of the gallo-nitrate as completely unfits a brush for a second, as the dipping of a sheet of paper in ink would unfit it for writing upon. It will be found an improvement to apply it in the following manner:—Pour out the solution upon a clean slab of plate glass, diffusing it over the surface

to a size corresponding to that of the paper. Holding the paper by a narrow upturned margin, the sensitive side is to be applied to the liquid upon the slab, and brought in contact with it by passing the fingers gently over the back of the paper, which must not be touched with the solution.

22. It has been recommended at this stage, "to let the paper rest for half a minute, and then to dip it into water, and dry it with blotting paper," which, I apprehend, has been the fruitful cause of much failure and disappointment, by the staining and embrowning of the paper, and by the partial removal of its sensitive surface.

23. As soon as the paper is *wetted* with the gallo-nitrate, it ought instantly to be removed into a dish of water; five, or ten, seconds, at the most, is as long as it is safe, at this stage, to leave the paper to be acted upon by the gallo-nitrate; in that space of time it absorbs sufficient to render it exquisitely sensitive. The excess of gallo-nitrate must immediately be washed off, by drawing the paper gently several times under the surface of the water, which must be perfectly clean, and, being thus washed, it is finished by drawing it through fresh water, two or three times, once more. It is now to be dried in the dark in the manner described in §19, and when surface-dry, it may either be placed, while still damp, in the camera, or in a port-folio, among blotting paper, for use. If properly prepared, it will keep perfectly well for four and twenty hours at least, preserving all its whiteness and sensibility.

24. The light of a single candle will not injure the paper at a moderate distance; but the less the paper, or the exciting solution, is unnecessarily exposed, even to a feeble candle-light, the better. Common river, or spring, water answers perfectly to *wash* the paper, distilled water being required for the silver solutions only. Stains of "gallo-nitrate," while recent, may be removed from the fingers by a little strong ammonia, or by the cyanide of potassium. The third process is that of

25. *The Exposure in the Camera,*—For which, as the operator must be guided by his own judgment, few directions can be given, and few are required. He must choose, or design, his own subject; he must determine upon the aperture to be used, and judge of the time required, which will vary from a few seconds to three, or four, minutes. The subject ought, if possible, to have a strong and decided effect; but extreme lights, or light colored bodies, in masses, are, by all means, to be avoided. When the paper is taken from the camera, very little, or, more commonly, no trace, whatever, of a picture is visible until it has been subjected to the fourth process, which is

26. *The bringing out of the Picture,*—Which is effected by again applying the "gallo-nitrate" in the manner directed in §21. As soon as the paper is wetted all over, unless the picture appear immediately, it is to be exposed to the radiant heat from an iron, or any similar body, held within an inch, or two, by an assistant. It ought to be held vertically, as well as the paper, and the latter ought to be moved, so as to prevent any one part of it becoming dry before the rest.

As soon as the picture is sufficiently brought out, wash it immediately in clean water to remove the gallo-nitrate, as directed in §23; it may then be placed in a dish by itself, *under* water, until you are ready to fix it. The most perfect pictures are those which "come out" before any part of the paper becomes dry, which they will do if sufficiently impressed in the camera. If the paper be allowed to dry before washing off the gallo-nitrate, the lights sink and become opaque, and if exposed in the dry state to heat, the paper will embrown; the drying, therefore, ought to be *retarded*, by wetting the back of the paper, or the picture may be brought out by the vapor from hot water.* The fifth and last process is

27. *The Fixing of the Picture,*—Which is accomplished by removing the sensitive matter from the paper. The picture, or as many of them as there may be, is to be soaked in warm water, but not warmer than may be borne by the finger; this water is to be changed once, or twice, and the pictures are then to be well drained, and either dried altogether, or pressed in clean and dry blotting paper, to prepare them to imbibe a solution of the hyposulphite of soda, which may be made by dissolving an ounce of that salt in a quart (forty ounces) of water.† Having poured a little of the solution into a flat dish, the pictures are to be introduced into it one by one; day-light will not now injure them; let them soak for two, or three, minutes, or even longer, if strongly printed, turning and moving them occasionally. The remaining unreduced salts of silver are thus thoroughly dissolved, and may now, with the hyposulphite, be entirely removed, by soaking in water, and *pressing* in clean white blotting paper, alternately; but if time can be allowed, soaking in water alone will have the effect in twelve, or twenty-four, hours, according to the thickness of the paper. It is essential to the success of the fixing process, that the paper be, in the first place, thoroughly penetrated by the hyposulphite, and the sensitive matter dissolved; and next, that the hyposulphite compounds be effectually removed. Unless these salts are completely removed, they induce a destructive change upon the picture, they become opaque in the tissue of the paper, and entirely unfit it for the next, which is

28. *The Printing Process.*—The picture being thus fixed, it has merely to be dried and smoothed, when it will undergo no further change. It is, however, a *negative* picture, (§4) and if it have cost some trouble to produce it, that trouble ought not to be grudged, considering that you are now possessed of a matrix which is capable of yielding a vast number of beautiful impressions. I have had as many as fifty printed from one, and I have no doubt that as many more might be obtained from it.

29. The manner of obtaining these impressions has been so often described, and there are so many different modes of proceeding, that it may be sufficient to notice very briefly the best process with which I am acquainted. Photography is indebted for it to Mr. Alfred Taylor, the eminent chemist, whose pamphlet on the subject will supply

* I now find that a horizontal jet of *steam* answers better than any thing I have yet tried.
† Specific gravity 1014.

every detail. His solution is made by dissolving one part of nitrate of silver in twelve of distilled water, and gradually adding strong liquid ammonia, until the precipitate, at first produced, is at length *just* re-dissolved.

30. Some paper is to be met with containing traces of bleaching chlorides, which does not require any previous preparation; but, in general, it will be found necessary to prepare the paper, by slightly impregnating it with a minute quantity of common salt. This may be done by dipping it in a solution in which the salt can barely be tasted, or of the strength of from thirty to forty grains to a pint of water. The paper, after being pressed in clean blotting paper, has merely to be dried and smoothed, when it will be fit for use.

31. The ammonia-nitrate of silver is applied to the paper in the manner described in §15, and, when perfectly dry, the negative picture to be copied is to be applied to it, with its face in contact with the sensitive side. The back of the negative picture being uppermost, they are to be pressed into close contact by means of a plate of glass, and, thus secured, they are to be exposed to the light of the sun and sky. The exposed parts of the sensitive paper will speedily change to lilac, slate-blue, deepening towards black, and the light, gradually penetrating through the semi-transparent negative picture, will imprint upon the sensitive paper beneath a *positive* impression. The negative picture, or matrix, being slightly tacked to the sensitive paper by two mere particles of wafer, the progress of the operation may from time to time be observed, and stopped at the moment when the picture is finished.

32. It ought then, as soon as possible, to be soaked in warm water, and fixed in the manner described in §27.

33. In these pictures there is a curious and beautiful variety in the tints of color they will occasionally assume, varying from a rich golden orange to purple and black. This effect depends, in a great degree upon the paper itself; but it is modified considerably by the strength of the hyposulphite, the length of time exposed to it, by the capacity of the paper to imbibe it, and partly, perhaps, by the nature of the light. Warm sepia-colored pictures may generally be obtained by drying the paper, by pressure, and making it imbibe the hyposulphite supplied in liberal quantity.

The paper of "I. Whatman, Turkey Mill," seems to give pictures of the finest color, and, upon the whole, to answer best for the purpose; and the successors of that gentleman, the Messrs. Hollingsworth, being so obliging as to prepare some paper with a little salt added to the sizing material, it is to be hoped, from its requiring no trouble, or preparation, injurious to its surface, that the demand for it will be such as to induce them in future to manufacture it as an article of commerce.

If the chemical agents employed be pure, the operator, who keeps in view the *intention* of each separate process, and either adopting the manipulation recommended, or improving upon it from his own resources, may rely with confidence upon a satisfactory result.

Lond., Edin. & Dub. Phil. Mag.

Account of Steel-Making at the Fitzalan Steel and File Works, Sheffield.

The "converting furnaces" are the scene of the first stage in steel making. The object in view is to saturate iron bars with carbon to such an extent as to change their quality from iron to steel. The bars so saturated are of various widths, and are partly Swedish, and partly English, according to the purposes to which the steel is to be applied. These bars, when adjusted to convenient lengths, are packed, or piled, up in the converting furnaces in a singular manner. Each converting furnace, viewed outwardly, has somewhat the shape of a glass house, being a sort of conical covering to an oven of very large size. The oven contains two oblong receptacles, or troughs, each measuring nearly twenty feet in length, about a yard deep, and the same in width. They are so placed, with respect to each other, that a strong body of flame may play around both of them, and raise to a high heat whatever may be placed in them.

On the bottom of each trough is placed a layer of coarsely powdered charcoal; then a layer of iron bars, placed side by side, as many as the width will admit; then another layer of charcoal; then a layer of iron bars, and so on till the trough is filled, at which time it contains more than thirty alternations of iron and charcoal. The surface is covered with a clayey substance called *wheelswarf*, derived from the abrasion, or wear, of the numerous grind-stones used at Sheffield, made into a kind of cement, or putty. A fire is kindled with Sheffield coal, (which is found to be excellently adapted for this purpose,) and kept up fiercely for many days. During this time the iron is in a red hot, or, perhaps, a white hot, state; the charcoal is also highly heated, and the iron seems gradually to absorb a portion of charcoal into the very heart of the bar. The coating of wheelswarf prevents the charcoal from burning away, and thereby leaves it in a condition to act upon the iron. One of the bars is so placed in the trough that it can be drawn out occasionally without disturbing the others; and from the inspection of this bar the workman tests the progress of the operation. Steel, for coach-springs, requires less of this action, or a "lower degree of conversion," and is, therefore, exposed to a lower heat than any other; steel for numerous common articles of manufacture requires a higher conversion; steel which is afterwards to be "sheared." or hammered, for knife-blades, and other purposes, still higher; steel for files requires a yet higher degree of conversion; and steel, which is afterwards to be cast in a fluid state, requires the highest of all. The business of the steel converter, therefore, is one of some nicety, demanding the exercise of care and judgment.

The bars of iron when removed from the converting furnace, are in that state which procures for them the name of *blister-steel*. They have absorbed only about one per cent. of carbon, yet their quality is greatly changed. The steel in this form, is not regarded as a material for manufactures, except for coarse goods; it is carried to a further stage before it has the necessary compactness and completeness for

use in finer work, since the blisters, even if no other defects existed, would unfit it for all but coarse purposes. It obtains the name of *common steel,* when, after being again heated, it is hammered with a very ponderous hammer, whereby a tougher quality is imparted to it. The most customary process to which it is next subjected, is *shearing*—a name worthy to be classed among those which illustrate the odd nomenclature of manufactures. When we see "shear steel" stamped on table-knives, we may not inaptly imagine that it is steel which has been cut with a pair of shears; but the connexion is more remote. This steel, soon after its introduction, being found suitable for making shears, it obtained the name of *shear-steel,* and by another step in the same road, the process came, at length, to be called *shearing*—a name about as consistent as it would be to apply the term *shoeing* to the process of tanning a calf-skin, on the ground that it makes leather fit for shoes.

The process of shearing steel is somewhat analogous to the welding of iron. It consists in heating several pieces, and hammering them one upon another, until all form one mass, greatly more dense, compact, and tough than the blister steel from which it was made. This department of the manufacture introduces us to a part of the works where some new features of arrangement demand our notice. The *tilt-house,* or the *shear-house,* is a building constructed with especial reference to strength, and resistance of vibration. On entering this building we see on the left hand furnaces for bringing the pieces of blister steel to a proper heat for welding, or shearing; while before us are three hammers of enormous size, and remarkable construction. The centre one of these hammers is the shear-hammer, employed in the operation now under notice, while the other two are tilt-hammers, for a process which will be noticed further on. Each hammer consists of a mass of iron with a steel face, fixed at the end of a ponderous mass of wood bound with iron hoops; and all these three handles are connected with a revolving shaft, or drum, worked by a steam engine. There is mechanism attached to this end, whereby the huge hammer is worked up and down with great rapidity, much in the same way as hammers are used by hand. So far the arrangements seem clear enough; but it is not until we consider the vibratory and shaking action of a hammer weighing twenty cwt. in rapid motion, that we can rightly understand the necessity for enormous strength in the building. Any ordinary structure would be shaken to pieces under this visitation; and hence a foundation has to be laid to a surprising depth, to prevent this result. In the first place the drum, or revolving shaft, for the three hammers, weighs thirty-six tons, and the bearings for this rest upon a mass of stone work twenty feet deep, formed of ten cubical stones weighing seven tons each. Then, as the anvil, or flat mass, of steel on which the blows of each hammer fall, must bear up against this immense concussion, it is placed on a mass of stone weighing seven tons, and this again is supported by a tree, or a trunk, of timber thrust upright many yards deep in the ground, and bound round with iron hoops. Altogether, therefore,

there is a vast deal of underground work to fit this tilt-house for the purposes to which it is applied.

In this building, then, the steel is sheared and tilted. The bars of blister steel are broken up into pieces about a foot long. These are heated in a furnace, or forge, and when at a white heat they are brought under the operation of the large tilt-hammer, by which they are beaten out to thirty inches in length. To change these pieces into shear-steel, half a dozen of them are put one upon another in a pile, and fixed firmly at one end in a groove, or long handle. The group thus connected is placed in a furnace to "soak," according to a technical phrase, that is, to be partially heated, preparatory to a more intense heating. The group is taken out of this first furnace, and transferred to another, where a fierce fire brings it to a white heat. The workman attends carefully to the state of the steel while in the furnace, as great nicety is required in the degree and equalization of the heat attained. When sufficiently heated, the group (still held by the handle) is taken out of the fire, and placed under the largest, or shear, hammer, where it is beaten on all four sides until all the pieces become thoroughly amalgamated, or welded, one to another, and the result appears in the form of a bar of steel two or three inches square. Each hammer has a kind of blast-pipe, to blow dust and dirt from the anvil beneath. In some cases the bar is cut in two, heated again, and again welded, whereby the process is carried still further. According to the degree to which it is welded, or sheared, the steel is called "double shear," "single shear," or "half shear." During the heating, preparatory to the hammering, the group of pieces requires a degree of attention whereby the workman is exposed to a very intense heat.

The shear-steel, made by this process, when closely examined, is found to have lost all the flaws and blisters which distinguished it as blister-steel, to have acquired a uniformity of character throughout, and to be greatly more malleable and tenacious than it was before.

There is, however, yet to be described a kind of steel more important than either of those hitherto described, and one to which the beauty of modern steel goods, is, in great part, indebted; we allude to *cast-steel.* As the heat employed in melting steel is the greatest which the manufacturing arts of any country exhibit, the furnaces, the crucibles, and all the apparatus employed, must be so formed as to endure this heat; and we must, therefore, notice these appliances before we can understand the process itself.

The crucibles, or melting pots, are rather less than two feet in height, and have a somewhat sugar-loaf shape. They are made of Stourbridge clay, wrought to the greatest possible degree of uniformity, and smoothness. To give this uniformity, the clay, after being mixed with water, and well worked up, is spread out in a thin layer on the floor of a room under the casting-house. Two men, with naked feet, tread, or trample, on the clay, uninterruptedly, for five, or six, hours, walking, or jumping, or dancing, or shuffling, (for it is hard to know which to call it,) over and over again, from side to side, and from end to end, until every particle of clay has been trodden repeatedly. It might seem strange why some kind of mill should not be employed

in this operation; but those who are most likely to understand the matter, state that no other method equals this for bringing the clay to a perfect uniformity of substance, and expelling all air-bubbles. When the clay is prepared, it is made into crucibles weighing about twenty six pounds each, by fashioning it in a mould having a core to give the internal form. The crucibles, as they are made, are placed in a vault where both air and warmth can come to them; and, when dried by this means, they are placed, on the night before they are to be used, on an annealing grate, where they are covered with cinders, and allowed to remain till the next day. These operations of crucible-making are continued uninterruptedly, for, notwithstanding the care and trouble bestowed, each crucible will only last one day.

The cast-house consists of two rooms, or compartments, both paved with stone, and each containing six melting furnaces. These furnaces are very different from others which we have had to mention; for they exhibit to the eye nothing but a hole in the floor about 18 inches square. There are six of these holes in a row in each shop, and so long as they are covered by iron covers, or lids, there is nothing particular to be seen; but when one of these lids is removed, a fearfully intense heat is shot upwards from beneath. Each hole is the mouth of a furnace, and each furnace is a cell measuring about four feet deep by eighteen inches square, being merely large enough to contain two crucibles with the requisite quantity of fuel. There is a grate beneath, through which a powerful draught ascends to the fuel; and there is a flue at one end to carry off the smoke and heated gases. Neither bellows nor blast-engine is used; the intense heat being wholly excited and maintained by the judicious admission of air from a vaulted chamber beneath. The walls of these small furnaces are exposed to such a destructive temperature, that the selection of the material, with which they are lined, becomes a matter of much importance. This material obtains the name of *ganister*. It is a kind of stone found near Sheffield, and is used, in the first instance, as road-metal, after which, when ground to dust by wheels and horses' feet, it is collected and made into a plaster, or lining, for the furnaces.

Let us now see what passes in one of these cast-houses. Each crucible-full of metal requires about four hours to effect its perfect fusion; and there are three successive meltings in twelve hours. Each furnace is supplied with coke to a certain height, and the two pots, or crucibles, are adjusted within it, side by side. More coke is then thrown in, until both pots are entirely surrounded by it. Here they are left to be acted upon by the fire, until they are brought to a dazzling white heat. The cover of the furnace is opened, and a long funnel made of sheet-iron is let down into each pot, having its open end at a convenient height above. The steel, broken up into small fragments, and amounting to thirty, or forty, pounds for each pot, is thrown into the funnel, and allowed to fall down into the pot. The funnel is then removed, the cover put upon the pot, coke added so as to enclose it completely, and the lid of the furnace put on. From time to time, during the ensuing period of four hours, the lid is removed, and the progress of the melting watched, more and more coke

being added when necessary, so that ultimately there are from four to five tons of coke used in melting one ton of steel.

As the time approaches for the casting, the men make preparations which sufficiently indicate the sort of "fire-king" ordeal to which they are about to be exposed. They cover their legs and body with coarse sacking, or leather, saturated with water from a trough at hand, and prepare to fill the ingot-moulds with the melted steel. These moulds are formed of metal, so shaped as to give oblong bars, or ingots, weighing from thirty-six pounds to two hundred pounds each, according to circumstances. Each mould is divided into two halves, which halves are bound closely together when the casting is about to take place. The mould is first coated on the inside with a kind of oily composition, closed up tightly, and placed vertically in a hole in the stone floor of the cast-house, with the upper end open. One of the men draws off the lid of a furnace, and the white-hot coke is removed from about the pot which is about to be emptied. A man then takes a long instrument acting like pincers, or tongs, hovers over the furnace in a manner which is almost fearful for a spectator to witness, puts the tongs down into the furnace, grasps one of the pots firmly, and draws it up; having, during this time, his face directly over a furnace, so intensely heated, as to convert steel into a liquid, and drawing up, in this hazardous position, a white-hot crucible weighing, with its contents, sixty pounds. He rests the glowing mass with its lower end on the floor; another man strikes off some of the adhering slag with a long iron bar; a third man grasps the crucible with an instrument held horizontally; the first man loosens his hold, and, with his tongs, takes off the cover of the crucible; the third man lifts up the mass, (no trifling weight when held horizontally at the end of a bar,) goes to the ingot-mould, and pours the liquid steel into it; while a fourth man, standing before him, clears the liquid stream from any impurities as it flows, by means of a long rod. Thus all four have their prescribed office, and no description can give an adequate idea of the scene which is presented. The terrible yawning mouth over which the first man hovers, the glowing mass which he draws forth, the intense whiteness of the liquid steel as it flows into the mould, the profusion of delicate greenish sparks which shoot forth during the pouring—all form a spectacle, which, when once seen, will not be soon forgotten.

The part of this operation which exposes the workman to the greatest heat, is that of drawing the pot from the furnace; but the part requiring most skill is that of "teeming," or pouring, into the mould, since it is necessary that the liquid stream should fall directly down the centre of the mould, without striking against the sides more than can be avoided. The eyes of the men are weakened by the intense glare to which they are exposed, but it does not appear that the general health suffers in any marked degree; yet a stranger may well marvel how any human frame could bear such a trial for years together.

Immediately after each pot is emptied, it is returned again to the furnace, again brought to a white heat, again filled with pieces of

steel, and again exposed to four hours' heating. After this has occurred three times, or one entire day, the melting-pot has rendered its services, and is then cast aside to be replaced by another. With regard to the steel thus melted, certain important changes have taken place within the last few years. It has often been conjectured that the Swedish iron derives some of its valuable properties from the presence of a small quantity of manganese; and within the last few years manganese has been introduced as a material to be added to the bar-steel in the melting-pot, in order to impart to the cast-steel certain valuable qualities which it did not possess before this improvement was introduced—such as a facility for being worked up into certain articles of cutlery. The history of the invention is rather complicated, and involves some of those unpleasant features of which our patent laws exhibit too many examples. The invention was, we believe, placed in a practical form, and patented by a Mr. Heath, but through certain technical flaws in the specification, the method has become thrown open to all; Sheffield has been greatly benefited, but the inventor has not. There is now a large quantity of carburet of manganese used weekly by the steel-melters of Sheffield; and the use of cast-steel for table-knives, and other articles of cutlery, has been one of the results of the invention. The matter is not one for discussion here, but it seems a pity that an invention which benefits a whole town should not benefit the inventor.

If the cast-steel is for the purpose of making saws, the ingots are rather flat, so as to be conveniently rolled into sheets at the rolling-mill; but if for other purposes, they are generally about as thick as they are wide. The rolling of steel into sheets, or into bars, is so precisely analogous to that observable in the iron manufacture, that the same description suffices for both. The rolls are very ponderous, weighing as much as five hundred pounds each; and when they are about to be used, the steel, whether "shear," or "cast," is heated in an adjoining furnace, and passed repeatedly between the rolls while yet red hot, by which it assumes the form either of bars of any required shape, or of sheets.

The *tilting* of steel is another curious process, the object of which is to close the pores of the steel, and to render it as dense and compact as possible. All steel for the best articles is tilted before being applied to use, whether it be "shear," or "cast." The tilting is one of the operations carried on in the building described in a former paragraph as being constructed with such great strength. There are two swings, or suspended cradles, in the tilt-house, one near each tilt-hammer. In these swings the men sit while holding the bars of steel to be tilted; since they can move their bodies to and fro (to bring every part of each bar under the operation of the hammer,) more easily when they thus sit, paddling along with their feet, than if they stood, or walked. The bars of steel are heated to a certain temperature in an adjoining furnace, and are then brought under the action of the tilt-hammer, where a deafening clatter is kept up for some minutes, accompanied by a vibration all around, which would shake to pieces any but a building of great strength.

It is one of the peculiarities of Sheffield, that tilting is a trade by itself. In a map of the town we may see marked Mr. So-and-so's "*Tilt*," for, with the usual brevity of technical language, the whole building, with its hammers and furnaces, is called a tilt. These tilts are mostly situated on the banks of some one, or other, of the rivers which flow through Sheffield, and it is impossible to mistake them when once in their neighborhood. There is one, for instance, close to the Lady Bridge, where, from morning till night, there is an incessant thumping, which shakes the very roadway itself. These tilters, or proprietors of tilt-works, receive steel in the form of bars, from any parties, and pass it under the tilt-hammers, after which their occupation is ended.

Lond. Penny Mag.

Account of the Introduction of the Manufacture of Porcelain in France, by Bernard Palissy.

Palissy was born in some village, the name of which is unknown, in the diocese of Agen, about the year 1500; he followed the humble calling of a land surveyor, to which, as he advanced in years, he added that of painting on glass.

At that period the art of porcelain-making was unknown. The discovery of Herculaneum and Pompeii have enabled us to determine the progress made by the ancients in the arts of pottery; and in the beginning of the sixteenth century, the only manufactory of crockery which could pretend to the name of porcelain, was at Fænza, in Italy, whither it is said to have been transported from China, by certain Venetian merchants. From this manufactory was derived the name of *faïënce*, or *fayence*, still used in France.

It happened that, in a visit to Agen, Palissy, the painter on glass, obtained a sight of a specimen of fænza, or of Oriental porcelain, which inspired him with the hope of discovering some sort of white enamel, by which earthen-ware might be encrusted; and from that moment he devoted fifteen years of his life to the pursuit of this single object. It appears a simple method to have proceeded at once to Fænza, and become a workman in the famous pottery. But means for so long a journey, were, probably, wanting to the poor village geometer, and he accordingly gave to the enterprize all that was in his *power*, every moment of his days, and every faculty of his mind.

As a painter on glass, the art of mixing and fixing colors was well known to him; but the difficulty of transferring these to pottery-ware, and covering them by a transparent silicious varnish, seems to have baffled his most persevering endeavors. Scarcely able to provide for the maintenance of his wife and family, he had the greatest difficulty in procuring colors and pottery to effect his experiments. Half his time was lost in grinding and pounding materials, and the vain attempt to construct the necessary ovens: at length he contrived to interest the owner of a pottery, who undertook to bake for him his experimental pieces; but partly from ignorance, partly from ill-will, the attempt was inexpertly made, and, ruined in fortune, health, and spirits, at the close of twelve years of incessant labor, Palissy was

compelled, by the wants of his family, to abandon his pursuit, and resume his more thriving calling as an engineer. Having obtained from the district a commission for the draining of certain salt marshes, he executed his task with credit and profit. No sooner, however, had he obtained the means of continuing his attempts, than he returned with greater diligence than ever to his enameling, and despatched the new samples of his skill to be baked in the furnace of a glass-house.

And now, for the first time, the composition he had invented proved fusible. Out of *three hundred* specimens of various experiments submitted, at the same time, to the action of the furnace, a single one presented, on cooling, a hard, white, vitreous, brilliant surface; and the joy of poor Palissy, in the discovery, may be easily conceived.

"I was, however, at that time of my life so simple," says he, in his narrative of his experiments, "that the moment I had hit upon the real enamel, I set about making the pottery-ware to which it was to be applied; and, after losing eight months in the task, I had next to construct a furnace similar to those of the glass-houses, in which it was to be baked. No one can conceive the trouble it cost me, for I had to do all by the single labor of my hands—to sift the mortar, and even to draw the water with which it was to be mixed. I had not so much as the help of a single man in fetching the bricks: my own back bore all!

"My first baking prospered pretty well; but when it came to the second, after the enamel had been spread over the pottery, I was unable to produce the heat necessary for the fusion. Six days and nights did I remain feeding and watching the furnace, half distracted, and almost stupefied by the intense heat, and my own bitter disappointment. At last it occurred to me that the composition contained an insufficient proportion of the substance which had produced fusion in the former instance; and I accordingly set about grinding and pounding, though still obliged to keep up the fire of the oven, so that I had treble labor on my hands.

"The former pieces being now spoiled, I was forced to go out and purchase new pots to be covered by the fresh composition; and, on my return, I had the misery of discovering that my stock of wood was exhausted! What was to be done? I rushed into my garden, and tore up the trellises; and these being insufficient, was obliged to sacrifice the dressers, stools, tables, and boarding of my house! All these were successively thrust into the furnace, in the hope of melting the enamel!"

The reader will probably recall to mind the account given by Benvenuto Cellini, in his memoirs, of having contributed all his pewter dishes and household utensils to the metal prepared for his noble statue of Perseus, which proved slow and difficult of fusion. But the Italian protégé of princes makes a vaunt of *his* sacrifice, whereas the meek Palissy couches his statement in the terms of a confession.

"Scorched by the heat of the furnace," says he, "and reduced to a skeleton by the transpiration arising from this prodigious heat, I had now a new vexation in store for me. My family having indiscreetly

circulated the report of my taking up and burning the flooring of my house, I was considered insane by my neighbors, and my precarious credit totally destroyed. If I had then died, I should have left behind me the name of a madman who had ruined his family by a frantic speculation. But though sick and dispirited, I cheered myself with the certainty that the discovery of which I had been so long in pursuit was effected; and that henceforward I had only to persevere in my labors. The difficulty of maintaining my family for five, or six, months longer, till a satisfactory result could be obtained, was the first consideration; but in order to hasten the period, I hired a potter to assist me in my work, furnishing him with models and materials.

"A cruel drawback it was, that I was unable to maintain this man in my dismantled home, for I was forced to run up a bill for his board at a neighboring tavern. Nay, when, at the end of six months, he had made me the various articles of crockery according to my designs, so that nothing remained to be done but to cover them with my enamel, and submit them to the furnace; being forced to dismiss my workman, I had no means of paying him his wages, except by giving him my clothes, which I accordingly did; and my person was now as thoroughly dismantled as my house!"

All the rest of his labors, poor Palissy had to encounter alone, though his hands were so cut and bruised with his work, that he was obliged, he says, to eat his pottage as well as he could with his hands wrapped in linen rags. The hand-mill, in which he ground his materials, required the power of two strong men to work it, yet he was wholly without assistance. Nor were his disappointments yet at an end. After having, with infinite pains and considerable cost, constructed a new oven, it turned out that the mortar he had used was full of flints, probably the refuse of his materials; and when the furnace was heated, these flints flew, and attached themselves to his pottery, so that it was completely spoiled.

"On passing the hand over my vases," says he, "little fragments of flint were perceptible, which cut like a razor. I instantly determined to break them up, rather than sell them in a deteriorated state for what they would fetch, which might have injured the reputation of my discovery. But no sooner had I done so, than I was beset by the maledictions of my starving family, and the mockery of my neighbors, who treated me as a madman for not having realized a few crowns by my damaged goods."

Nevertheless the man of genius toiled resolutely on!—Satisfied of the strength that was in him, and of the importance of his discovery, he went to work again, with an injured credit and constitution, an object of hatred to some, and contempt to others. From the exhausting nature of his labors, his arms and legs had become like sticks, so that, according to his own brief description, there was nothing to keep up his garters, and his stockings came upon his heels as he walked, till he was the picture of wretchedness and destitution. Between the action of the prodigious heat of his furnace, and the influence of the rain and frost on his ill-constructed works, the place was frequently unroofed, compelling him to borrow the materials for its reparation.

But this was not always to be accomplished; and he tells us that he often remained watching his oven through the winter nights, exposed to wind and weather, with the owls hooting on one side, and the dogs howling on the other.

"Wet to the skin with the beating in of the heavy rains, and groping about in the dark, for want of a candle, I have often retired to rest at midnight, or even at day-break," says he, "looking like some drunken wretch who had been rolling in a gutter. But the worst I had to suffer was from the accusations of my neighbors, who had assisted me, and who now regarded me as a robber; and the reproaches of my family, who treated me as a selfish lunatic."

This is but a faint outline of the miseries and fatigues sustained by poor Bernard Palissy, in bringing to perfection an art which has proved so highly beneficial to his own and other countries. The furnaces and ovens of his invention are still in use at Sèvres, and have been closely copied in our own and other porcelain works. The moulds in which the vases are baked to secure them from accident, were devised by Palissy, after his unlucky loss from the flying of the flints; and his recipes for the mixing of colors are still patent.

The porcelain of Palissy soon attained a prodigious reputation, and few museums, or collections of objects, of *virtù*, in our own time, but contain specimens of his works, under the name of Raphael-ware, or china of the middle ages. The embossed dishes exhibiting reptiles and animals, in great perfection, were the invention of Palissy; and several of his dishes and vases present copies after celebrated pictures, executed in relief. Table services, to replace the wooden and pewter vessels then in use, were the chief objects to which he devoted his art; and with so much taste and skill, that many of the original designs exhibit the genius of a first-rate sculptor.

The fame of his discovery extended rapidly through France, and orders were given him by all the nobles of the court of Henri II: among others, by the Duc de Montmorency, who employed him to decorate his stately château of Ecouin. One of the chambers was paved with tiles of Palissy's porcelain, which still remain perfect, unless where the design has been destroyed by the introduction of one of those huge ungraceful N's, which, during the empire, were made to disfigure all the ancient public edifices of France.

Ibid.

Mr. Bain's Electric Printing Telegraph.

The dispute between Professor Wheatstone and Mr. Bain, as to the legal and moral standing of each in the matter of electro-telegraphs, and electro-clocks, has already been noticed by us at some length. We have no intention of alluding to that dispute further, on the present occasion, than to remark that it has not deterred Mr. Bain from pursuing the subject. Having completed a telegraphic apparatus, he has profited by the liberality of the directors of the South Western Railway Company, to fix it on their line, and to exhibit it

at the Nine Elms Station, to a great number of gentlemen interested in railways, and in the progress of science. The apparatus transmits signals to and from Wimbledon, a distance of *six miles;* its action, while we witnessed it, was extremely rapid, and very certain; every message (indicated by numbers,) was transmitted and returned correctly, the process of printing it going on in the meanwhile.

This important invention has some peculiarities which require to be separately noticed, before a correct idea of their joint effect can be obtained. 1st, it is now well known that if a metallic communication be made in one direction, between the distant parts of an electrical apparatus, water, or the moist earth, will serve safely for that in the other, or returning direction. Some part of the dispute before mentioned, referred to the priority of the discovery, or application, of this fact; and it turned out that neither of the present disputants was really the first who had observed it, although Mr. Bain certainly had re-discovered it. But the latter named gentleman has made another, and more important advance. In the former case the earth was merely found to be a safe medium for *transmitting* the electric fluid. He has now found that a considerable length of moist soil may be made to *generate* electricity enough to work a telegraph, by merely burying in the ground, or immersing in water, at two distant points, a sufficient surface of positive and negative metals, and connecting them by an insulated wire. In this manner is obtained the electrical power which controls Mr. Bain's telegraph. A copper plate being placed in water at London, and a corresponding zinc one at Wimbledon, the two being connected by a single copper wire, the artificial galvanic battery is entirely dispensed with. We may here add that Mr. Bain has found, that the greater the length of moist soil comprehended between the metallic surface, the more intense is the electric current obtained, although it is of less quantity. He finds also that this terrestrial electricity is very constant in its intensity. It is found that the telegraph can be worked with metal plates of only 4 square inches each, making 8 square inches of surface in each. The plates actually employed are each of one foot square.

Secondly, electro-telegraphs have chiefly hitherto been immediately actuated by the deflecting power of the galvanic current. If a needle, which freely vibrates on a centre, is placed in the middle of a coil formed of many convolutions of insulated wire, in such a manner as that it is parallel with the plane of the coil, and can vibrate freely, and if an electric current be directed along the wire, the needle will be deflected from its original position, and this deflection will take place to the right hand, or the left, just as the current may pass, in one direction, or the other, along the wire. A variety of contrivances have been employed for indicating, by the motion and direction thus given, to several needles, the message intended to be transmitted by the electric telegraph. The indication depended on the deflection of the needle by the immediate action of the galvanic force. In some, however, a weight was employed to move the machine, and the motion, thus obtained, was interrupted by bringing into action the parts of an electro-magnetic apparatus at the distant end, by means of

wires connected with a corresponding apparatus at the end from which the signal was made. In Mr. Bain's new telegraph the machine is actuated by weights, but its motion is stopped by a detent, until interruption of the galvanic current is made to release it at the pleasure of the operator at the other station. The acting power is here not in the electric current, but in the weight, and the current is required to be only of the trifling energy necessary to move the controling detent under very small pressure.

Each telegraphic system on Mr. Bain's plan consists of the plates and single wire already described, and of two machines, exactly alike, one at each of the two stations, between which the communication is to be made. The machines themselves form part of the metallic connexion between the plates. So long as the electric current flows without interruption, the machinery is quiescent, being locked by the detent; but the instant the connexion is broken, the detent makes a slight rotation, by which the clock work is disengaged, and the signalizing commences. It is preferred, and with good reason, we think, to make the rest of the machinery—not its motion—depend on the continuance of the connexion, since any failure of the electrical apparatus is then instantly brought to notice by its putting the machine in action.

The electro-magnetic apparatus, which is employed solely to actuate the detent, is constructed as follows:—A light vertical spindle carries a brass bar, on each extremity of which is fixed, by the middle of its length, a semi-circular magnet, the ends of the two magnets nearly touching each other, and the magnets themselves nearly completing a circle, of which the spindle is the centre. Two insulated wooden bobbins, affixed to the frame of the machine, are bored out large enough, longitudinally, to admit the magnets to pass through them without touching, and they carry the coils of wire which form part of the electric route. They are placed longitudinally to the magnets, and so that the ends of the latter meet within their central cavities. When the electric current is made to pass along these coils, the magnets, with their spindle, are made to rotate through a small arc in one direction; as soon as the current is interrupted, the power of these coils ceases, and a constant magnet, placed at a little distance, brings back the electro-magnets, and their spindles, to their original position. A protuberance on that spindle fulfils the office of detent, being cut on one side nearly to its centre; the extremity of a long light arm, which is carried by one of the last arbors of the clock-work, and, therefore, revolves rapidly, rests on this protuberance when it is in one position, and passes by its flat side when in the other.

Each machine consists of three parts, that which gives motion to a hand like that of a clock; that which, on the pointing out of a telegraphed figure, strikes a bell; and that which prints the figure. Supposing now the machine to be set agoing, by having made the necessary electrical disposition for releasing the detent, we observe, first, that the hand rotates in front of a dial, its point passing by the nine digits, a cipher, a large dot, a vacant space, and its starting place, arranged in a circle; next we see, that on the hand being stopped at

any figure, by breaking the electrical connexion, its part of the machine stops, the striking part begins to go, and soon strikes a spring bell, and the printing apparatus acts so as to leave an impression of the figure, at which the machine was arrested, on a piece of paper wound round a revolving cylinder on the left of the machine. This is repeated for any figure, or any number of them, which may have been desired. When the communication is closed, the same is done with the dot, or period. After waiting, perhaps, half a minute, the machine begins to go again, apparently of its own accord, but really by the action of the assistant at Wimbledon, and the same figures are repeated by the hand stopping at each of them, and printing it, and sounding the bell also as before. The same interruption of the electric current, which stops the machine at one station, stops also at the same instant that at the other; and as the hands of the two machines are originally set together, and afterwards revolved at the same speed, it is obvious that the figure at which one is stopped, will be pointed out at the same instant by the other. The printing is effected by types projecting radially from the periphery of a wheel. The types are so disposed on the periphery, and the wheel is so geared to the machinery which carries the hand, that when a given figure is pointed out on the dial, the same is presented by the wheel to the paper. The type wheel is pressed forward to imprint the figure on the paper.

The two machines, we have said, are exactly alike. The velocity of their rotation is regulated by small governors, like those used in steam engines, and it is necessary that the machines should pretty exactly agree in this respect. If, however, any error of this, or any other, kind should occur, so that the two machines do not point to the same figure at the same time, it is instantly discovered by the following contrivance: The machine, if left to itself, would stop at any one of the figures, or spaces; it goes only so long as the attendant keeps in due order the requisite metallic circuit. But to this there is one exception, that of the vacant space which we spoke of as forming part of the circle in which the figures are disposed; here the machine would not stop of itself. Now if the two machines arrive at this space at the same time, they will both pass over it without stopping; but if one of them points to this space, while the other points to a figure, a stop will there take place, by virtue of the action of the latter machine, and the attendant at the other then instantly perceives, by the improper stoppage on the vacant space, that the instruments do not agree. It is obviously easy to ascertain what is the figure to which the hand of each machine should point, to correspond with the other, since it will readily be seen what figure the hand of one machine passes over without spontaneously stopping, when left to itself.

This novel and highly ingenious telegraph seemed to us to act with perfect correctness in its construction, and the methods devised for its use. Most effectual precautions seem to have been taken against the undetected continuance of error. We understand that a telegraph of this kind has been at work satisfactorily for the last eighteen months. The importance of the physical discovery, on which its peculiar action depends, will not be disputed; and the invention, both in its effect,

and its details, will necessarily command the attention of the railway world. It is remarkable for simplicity; this, however, distinguishes not so much the mechanical parts, which are always in sight, and subject to ready comprehension, and easy repair, as the electrical connexion; here a single wire suffices, and a failure, if it were to happen, would be known to belong to that one wire, precluding the delay, vexation, and uncertainty which are occasioned by a like misfortune to one of the many wires required by other electrical telegraphs. Its comparative cheapness, and its facility of management, are important recommendations; but a still greater, we think, is the uniformity of its action, depending, as it does, not on batteries, whose power is constantly varying, but on the electricity of the earth itself. We congratulate Mr. Bain on this successful exhibition of the results of his long-continued labors, and we earnestly trust that neither pirates nor professors will again annoy him.

Lond. Mechanics' Mag.

Remarks on Parsons' Locomotive Expansive Apparatus.

TO THE COMMITTEE ON PUBLICATIONS OF THE JOURNAL OF THE FRANKLIN INSTITUTE.

Sirs,—The March number of the Journal of the Franklin Institute contains a description of "Parsons' Locomotive Expansive Apparatus." That part of the arrangement which provides an adjustable cut-off, by the use of two slide-valves attached to the same rod, one by right handed, the other by left handed, screws, and the mode, adjustment, &c., are precisely those for which I obtained letters patent in August, 1841. The *American Repertory*, for December, 1841, contained a part of my specification and claim.

The patent of Mr. Parsons is dated December, 1842, and was enrolled in June, 1843.

The "adjustable cut-off," as my invention is named, has been adopted on an engine lately put to work on the railroad from Jersey City to New Brunswick, to one on the Long Island road, and to engines building for the Patterson road, and for the Stonington road.

I intend soon to send you accounts of the performance of these engines, which have been very satisfactory, and shall also furnish a full description of the combinations embraced in my patent.

Yours respectfully, HORATIO ALLEN.

New York, May 14, 1844.

Metallic Sand.

At the meeting of the Society of Arts, of the 29th of January, 1843, the secretary read a paper by Mr. H. K. Dyer, on the metallic sand. This sand is produced by grinding copper slag by means of powerful machinery, and consists of iron, zinc, arsenic, and silica, the iron predominating: the slag is procured in abundance in Swansea. In chemical analysis it is very similar to the pozzolano, and in point of durability is found to be equal to the latter. With blue lias lime,

which is used for hydraulic works, the metallic sand readily enters into combination, and these having been used together for external works, exposed to all the changes of the atmosphere, have proved the indurating qualities of the metallic sand, after an experience of eight years. The metallic sand contains a greater proportion of iron than *pozzolano*, or any other material yet introduced to the public, and hence the indurating property which it possesses; and its granular form, and sharpness of its angles, must also be admitted as an additional reason for its extraordinary tenacity. As a concrete, it was mentioned that the metallic sand had been successfully employed in the entire foundations of the new Houses of Parliament, and was used by the Metropolitan Wood Paving Company, in forming the sub-stratum on which their blocks were laid, and who were so convinced of its efficiency, that they secured from the patentees the exclusive privilege of using it for such a purpose; and to the unyielding nature of their foundations may be attributed, in a great degree, the successful results which have attended the work executed by that company. As a mortar, it was admirably adapted for tunnels, sewers, sea and river walls, and inverted arches, as being impervious to damp, and increasing in hardness from atmospheric influences. In fresco-painting—a matter which is, at this moment, exciting so much attention for decoration in the new houses of parliament—it has been found highly valuable as a stucco for the walls; the combination of the colors with the material imparting an almost endless durability to the work, and the face of the painting might be left in the usual manner, or brought to the highest polish. The process of fresco-painting in Munich, adopted by Professor Hess, it was stated, had been inspected by Mr. W. B. Simpson, a decorator in London, and, in his opinion, the metallic sand cement was equal, if not superior, to any substance with which he had met, from its extreme density and hardness, and its effectual resistance to the entrance of any moisture. Specimens were laid on the table: 1st, brick work of a fresh water tank, which had been erected six years, was removed by a pick-axe; the bricks yielding to the strokes of the axe, but the cement remaining solid; 2nd, imitations of marble executed by a painter on the face of stuccoed work, formed of metallic cement, in conjunction with common chalk, lime, and putty, and afterwards polished; 3rd, a specimen of fresco-painting, also executed on a face similar to the above; 4th, a vase, the figures on which retain their original sharpness, although it has been exposed to the atmosphere for many years.

Glasgow Mech. & Eng. Mag.

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*Deposit of Gold recently discovered in the Ural.**

The mass of gold recently discovered in the Ural, is the largest known in the whole world. It was found in the gold bearing sands of Miask, in the district of Zlatooust, not far from the celebrated mines

* This article is an extract of a letter from M. de Kokcharoff, officer of the Royal Mining Company, to M. de Humboldt.—Translated from the *Annales des Mines*.

of Tzarevo Nikolæfsk, and of Tzarevo Alexandrofsk, in the southern Ural. These two mines, which you have visited with so much interest, have already yielded, as you are aware, nearly 400 pouds of gold, (6552 kilog.) equal to about 17,544.5 lbs.,—and, more than once, very remarkable masses have been collected there; thus, in 1825, they found there the specimen weighing 24 phounds 68 zolotniks, (10 kilog. 118) about 27.017 lbs. However, these mines beginning to be exhausted, they were compelled to make explorations near the course of the river Tachkou-Targanka, which soon led to the discovery of a bed of gold-bearing sands, of very great richness, but within very narrow limits. This bed once found, they turned off the stream, which had served for washing the sands, up the whole length of this river, and commenced their examinations in the dry bed of the stream. Their success was complete; they came at once upon a stratum of gold-bearing sands, of considerable extent, where the yield of gold was 100 pouds to 8 zolotniks, (a very great proportion, when it is remembered that sands giving 100 pouds to 1½ zolotniks have been before considered well worth exploring;) then other beds were discovered, of a yet greater capacity, which terminated in the examination of the whole valley of the Tachkou-Targanka, with the exception of the spot occupied by the buildings necessary for the washings. In the course of 1842, they pushed the works under the foundations of the building; the first attempts were not successful, but they soon came upon a spot of marvellous richness, where the yield was from 50 to 70 zolotniks of gold in one poud of sand; its extent, however, was very limited. At last, on the 26th of October, 1842, they found this monstrous mass, weighing 2 pouds 7 phouds 92 zolotniks, (36 kil. .020758) 100.078 lbs. It lay upon the strata of diorite, (a variety of trap) in the bed of gold sand, at the depth of 4½ archines from the surface, and under the corner of the building. The mass in question has already reached St. Petersburgh, and is placed at the museum of the Institute of Mining Engineers. A discovery which is equally worthy of our attention, is that of a bed of gold-bearing sands on the left bank of the same river before the dike, containing a considerable number of masses; already they have taken thence 52, weighing each from 1 lb. to 7 lbs. Russian.

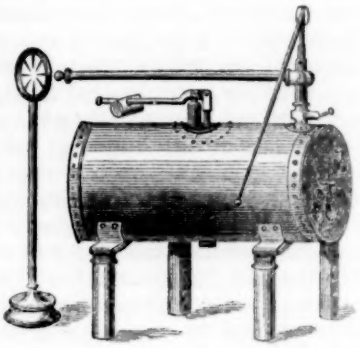
Note by M. Humboldt.—The largest piece of platina found, up to this time, at Nijni Tageulsg weighs 20 lbs., (Russian) 34 zolotniks. Piece of gold found at Miask, 10 kil. .119=27.0021 lbs. Piece of gold found in the United States, Anson county, N. C., 21.70 kil. = 57.939 lbs. Piece found at Rio Hayna, (1502) and lost in the depths of the sea, (see my critical examination of the geography of the new continent,) 14.500 kil.=38.715 lbs. Wonderful mass of miask found 1842, 36.020 kil.=100.077 lbs.

According to a letter from Count Cancrine, Dec. 3, 1842, Siberia, to the east of the Ural, produced, in 1842, the quantity of 479 pouds of gold=7.846 kil.=21,058 lbs., and the whole of Russia about 970 pouds =15.889 kil.=42,323.63 lbs.

Lond. Min. Journ.

Portable Hydro-Electric Machines. *By* CHARLES V. WALKER, Esq., *Editor of the "Electrical Magazine."*

There are several forms which have been given to the portable hydro-electric machines. The first to which we may allude is one constructed by Watson & Lambert, for Mr. Addams, the action of which was exhibited last summer, before the members of the United Service Institution; and the power of which we have ourselves had the opportunity of testing with Mr. Addams. It consists of a cylindrical boiler 30 ins. by 16 ins. Five tubes, in a lower row of three, and an upper row of four, traverse the boiler longitudinally. The boiler rests on a frame supported by four glass pillars. Before being placed in the frame, the steam is "got up," by means of an open furnace of a suitable shape; the steam is then "kept up" by a succession of iron heaters, each 15 inches long, which are thrust into the tubes last alluded to; the heaters being prepared in the furnace, after it is vacated by the boiler. A convex cover, applied to each end of the boiler, after the heaters are in, gives the requisite rounded form. One end of the boiler is furnished with a gauge water-cock, and a steam-cock. The boiler also possesses a safety-valve, which is adjusted as high as 90 lbs. Above the boiler rises a short tube furnished with a stop-cock; it enters an inverted hemispherical metal vessel, in which the requisite condensation occurs; from this the hydrated steam escapes through a tube, furnished with the usual box-wood jet. Mr. Addams obtains the electricity of the steam itself, by allowing it to blow through an insulated hollow metal cylinder, furnished within with wire gauze, or metal, points. The spark from the boiler is 10, or 12, inches long.



Mr. Gassiot has a small machine, made under his direction, of a metal globe of the capacity of two gallons; a globe, which was a gas holder, in the days of portable gas, and which can, therefore, bear a high pressure. The steam-tube rises from the top, and curves off at right angles; the jets are fitted up in the usual way. The globe is placed on a small metal tripod, beneath which is a chafing-dish containing charcoal; the whole stands on a square tile, supported by four glass pillars. When in good action, and by careful management, an attenuated spark of an inch may be obtained. Mr. Gassiot exhibited this instrument, and Dr. Pereira exhibited another, constructed after the same model, at the Soirée of the London Institution, held on January 17th last.

The prefixed engraving represents an elegant machine by Messrs. Watkins & Hill, the general construction of which corresponds with

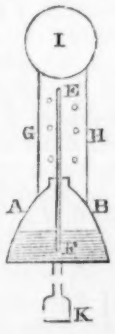
that of the one we first described. The rod, resting on the front of the machine, is a means for conveying the electricity to any piece of apparatus. The circle of converging points, for de-electrizing the steam, was adopted at our suggestion, in place of a mere fork. This machine will charge 70 feet of coated surface in a minute, with 20 grs. on the balance discharger.

We learn from Mr. Armstrong that very great improvements are continuing to be made in the construction of these machines. He speaks of one "capable of charging 110 square feet of coated surface in a minute, to 20 grs. of Cuthbertson's electrometer, and yet it only discharges as much steam as three of the jets belonging to the great machine of the Polytechnic." The great improvements appear to consist in having been able more duly to adjust the degree of condensation to the size of the jets. More suitable specimens of partridge-wood have also been obtained. Mr. Armstrong also mentions that the manufacturers are endeavoring to make some which shall be heated by naphtha lamps. One objection which may present itself against the use of these machines in a room, is the quantity of steam liberated; but this may easily be carried off by blowing the steam towards a fire, when it will ascend the flue. On the whole, it appears more than probable, that the power of these machines may be eventually so modified and exalted, as that they may hold an equal, perhaps a superior, rank, to the oft times troublesome instrument (for a lecturer especially,)—the frictional machine.

Mechanics' Mag.

Modes of Measuring the Depth of the Sea.

In a late article of the *Ann. de Chim. et de Phys.*, M. Aimé, describes an apparatus for sounding, in which a weight attached to the line, may, on reaching the bottom, be detached, so that the line is drawn up with very slight resistance. This apparatus is supplied also with a vessel for collecting water at different depths. M. Aimé has, with the assistance of this machine, made, at Algiers, a series of experiments at various depths from the surface, from about 350 to 2200 yards, from which he infers that the amount of gas absorbed by the water is nearly the same at varying depths, and that the same remark applies likewise to the saline constituents.



The annexed cut is a figure of the ordinary sea-gage employed when the fathom line cannot conveniently be used. A B, is a gage-bottle, into which is fixed the gage-tube E F, the upper end of which is hermetically sealed, and the lower immersed in mercury. This is inclosed for protection, in a tube G H, pierced with holes, which admit the water into the bottle; and the whole is crowned with a large empty ball, or a full blown bladder. To the bottom of A B, a large weight K, is connected by a spring.

The weight being attached to the instrument, they both sink, until, striking on the bottom of the sea, the weight is detached, and the globe I, is allowed to bring up the gage to the surface. In the descent, the water pressing on the surface of the mercury, causes it to rise in the gage-tube. By placing a small quantity of viscid matter on the surface of the mercury in the tube, the instrument becomes self-registering: the viscid matter will adhere to the tube at the highest level to which it is raised, and will, therefore, indicate the space into which the air in the tube has been compressed; consequently, the depth of the water which is reciprocally proportional to the space occupied by the air, may be ascertained.

Glasgow Mech. & Eng. Mag.

The Pendulum Marine Artificial Horizon.

The following letter from an officer employed last summer, in the survey of St. George's Channel, affords so remarkable an instance where the pendulum horizon, alluded to by Capt. Beechey, in our last, would have saved both time and anxiety for the safety of one of H. M. ships abroad, in which he happened to be serving, that we cannot resist the opportunity of quoting it here; and our satisfaction in doing so is increased on seeing it signed by that careful and well informed officer, the master of the *Lucifer*.

Greenwich, October 15th, 1843.

Dear Sir,—I am sorry that absence from town should have prevented my communicating to you, the opinion I have been able to form of your pendulum horizon, tried by us in the *Lucifer*.

The observations in your possession will speak for themselves. Although a stranger to the instrument, I found little difficulty in using it, and am of opinion that a moderately good observer, when accustomed to its use, may, at sea, under favorable circumstances, obtain altitudes within four minutes of a degree.

The great value of such an instrument must be obvious, and, although often placed in circumstances when it would have been invaluable, I will confine myself to one strongly impressed on my memory. In H. M. sloop Zebra, on our passage from Hobartown to Tahiti, we were enveloped in a dense fog, between the Snares and Lord Auckland's group, which lasted, as nearly as I can recollect, upwards of a week. Latterly, from the uncertainty of our position, it was considered necessary during the night to run a certain number of miles on opposite courses, to endeavor to keep, as nearly as possible, on ground that had been gone over. Although the fog was so dense that an object could not be seen at the distance of fifty yards, the sun was shining brightly over head, and, had your instrument been on board, I should not have felt the slightest anxiety, as the wind was light, and the water perfectly smooth. Could we, by any means, have obtained a latitude, even ten miles in error, it would have been most acceptable.

With every wish that it may come into general use,

I remain, &c., L. C. Bailey.

We take the following from the *Shipping Gazette* of the 13th of March.

Sir,—Among the new inventions of the day, permit me, through your paper, to draw attention to Captain Becher's horizon, which is not so well known to the merchant navy as its merits deserve, for it is calculated to be of essential assistance in navigation. It is a pendulum horizon, to be attached to the sextant, and is admirably adapted for obtaining the altitude of the sun at places where the land intervenes, or in foggy weather, and no horizon, although there may be a clear sky over head, as is frequently the case, for example, on the Banks of Newfoundland, and elsewhere. The instrument affords us the means of obtaining the latitude at times when it could not otherwise be arrived at by observation. Having used the instrument for several years, I unhesitatingly recommend it to the notice of those interested in such matters. For a description of the pendulum horizon, with the various uses to which it may be applied, the reader can consult a small pamphlet by the inventor.

I remain, &c., HENRY DAVEY,
Master R. N.
Lond. Naut. Mag.

Stephen's Life-Preserver, or Portable Life-Ball and Line.

This apparatus consists of a hollow metal ball, about five inches in diameter, to which are brazed, or riveted, three eyes, and a line fixed, of about twenty fathoms, or upwards, in length, of half inch Hambro' layed rope, having a sliding thimble to form the noose. In order to prevent its being damaged, it is quilted over with net-work, similar to a child's ball, being, however, first cased with cork, so as to render it more buoyant. Through one of the eyes is rove the line which passes round the ball, and is again brought through the eye in the opposite direction; both parts are then seized together outside the eye, leaving sufficient line, with a thimble in the end, to form a bight. The standing part of the line is then passed through the thimble, and a noose formed sufficiently large to admit of it passing over a person's shoulders, to fasten round his waist. The other two eyes are placed opposite to each other, through which a piece of line is rove round the ball, and seized in four places, so as to form grummetts, or handles, to the "life-ball," in order that it may be the more readily held, or caught hold of.

The life-ball, from its portability, can be carried to any part of the vessel, and thrown in the direction of the person overboard; whereas the life-buoy, when put in operation on a casualty occurring, although it may be immediately let go and dropped, yet, from its nature, will remain stationary in the wake of the ship, and, unless the person be a good swimmer, it is almost impossible he can reach it, particularly should he happen to fall overboard to leeward, a circumstance which more frequently happens than otherwise.

Lond. Journ. Arts & Sciences.

The Diamond Mines of Brazil.—The diamonds occur in masses of Itacolumite, upon the left bank of the *Corsego dos Rois*, on the Serra du grammagoa, forty-two Portuguese leagues north of the city of Tejuco, or Diamantina. The diamonds have been, for some years, profitably extracted by breaking up the rocks, and reducing the fragments to sand by means of hammers; they are then obtained by washing the sand. The washing, however, has now ceased, because of the increasing difficulties of extraction from the remaining rocks, as well as because diamonds are obtained with greater facility in other situations. A small diamond, separated from the Itacolumite, with which it was encased, has been examined by a commission of the Academy of Sciences; they have ascertained that it does not polarize light completely, and that its angle of maximum polarization is exactly the same as that given by a diamond from India, taken for the sake of comparison.—*Ann. de Chim.*

Platina in the Sands of the Rhine.—M. Dœbereiner has obtained 0.4 grain of platina, from one ounce of auriferous sand taken from the Rhine.

Lunar Occultations.

Lunar Occultations visible in Philadelphia during the month of July, 1844; computed by Mrs. Charlotte S. Downes, from the Elements published with the Occultation list of the United States Almanac.

The Immersions and Emersions are for Philadelphia, mean astronomical time. Im. for Immersion, Em. for Emersion. These abbreviations in *Italics* refer to those Immersions and Emersions which take place on the Moon's dark limb. N. App. for Near Approach.

The angles are for *inverted image*, or as seen in an astronomical telescope, and reckoned from the Moon's North point and from its Vertex around through East, South, West, to North and Vertex again. For direct vision add 180°.

JULY, 1844.

Day.	H'r.	Min.	Star's name.	Mag.	From North.	From Vertex.
1	8	50	Im. τ^1 Capricorni,	6	68°	116°
	10	3	*Em.*		264	305
1	9	53	Im. τ^2 Capricorni,	6	54	96
	10	59	*Em.*		272	306
8	16	21	Im. ψ Arietis,	6	358	49
	16	36	*Em.*		303	336
17	6	52	*Im.* Bessel,	9	154	103
	7	37	Em.		255	207
17	8	35	*Im.* Bessel,	8	170	120
	9	4	Em.		234	186
18	7	17	*Im.* Bessel,	7	118	69
	8	17	Em.		291	241
18	7	25	*Im.* Bessel,	9	78	29
	8	13	Em.		331	281
18	9	11	*Im.* Bessel,	9	183	133
	9	28	Em.		318	169
19	7	32	*Im.* Bessel,	9	122	75
	8	34	Em.		287	237
24	6	13	*Im.* δ Scorpii,	3	104	123
	7	33	Em.		281	282